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"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH.

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NATURE PRESERVATION AND NATIONAL LIFE

THIS War, like the War of 1914–18, with its demand for sacrifice from all the people, has given a jolt to the easy-going tolerance which, in times of peace, permitted the development and the continuance of social conditions universally regarded as intolerable. In Great Britain, at any rate after the War, a reawakening of the nation to its needs, with insistent urge for their satisfaction, are foregone conclusions, and promise of some readjustment of conditions is implicit in the post-war reconstruction policy of His Majesty's Government.

But if post-war reconstruction is not to miss a great opportunity it must not limit its efforts to re-arrangements of industry and populations as between town and country, restoration of security to the basic food-raising industries of husbandry and fishing, banishment of slums and reduction of disease, and similar essays to improve the material welfare of the nation or of its constituents. For the welfare of man's spirit, as well as his material good, demands forethought and planning, and the "nation of shopkeepers" is certain, and properly so, to put the latter first, and perhaps forget the other altogether in the difficulty of attaining throughout the nation even the lowest decent standard of economic independence and health, to say nothing of happiness.

Indeed we can say that one aspect of this more subtle welfare has been forgotten, or almost forgotten, by the Governments which have represented our people—the opportunity for sharing in that pleasure, mental uplift and healthy recreation which is associated with great open spaces and the beauty of Nature. It is a matter in which the Governments of most civilized countries have far out-distanced the leaders of our own nation. Rightly our legislators may plead that the people has never with one voice demanded such amenities, and this cannot be gainsaid, but the position is no different in other lands, for even of the United States, with its enormous area of Nature reserves, it has just been written, "a great part of the public is indifferent to the success of wildlife conservation"*. There the Government, itself guided by a few enlightened pioneers, gave the lead, and now it expends much thought and money in endeavouring to educate the people to make the best use of their own Nature possessions, although of course there is a nucleus of the American nation which takes full advantage of its opportunities.

We plead, therefore, for the inclusion in His Majesty's Government's review of post-war planning, of consideration of the value and the possibility of setting aside as national heritages areas for the people. The difficulties do not appear to be greater than those which have been surmounted in less wealthy nations. Density of population and the area under cultivation offer no greater obstacles here than in many European countries. Indeed, of land which may be regarded as almost unproductive the U.S.S.R. and Spain have about 20 per cent, France 14 per cent, Italy 13 per cent and Germany 9 per cent, while the proportion in Great Britain is roughly 18 per cent. Surely there is room here for the areas we have in mind.

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* Ira N. Gabrielson, "Wild-Life Conservation", 1941, p. 241.

These areas should be of three kinds, conveniently specified in a memorandum just issued as the result of a conference of representatives of British organizations interested in the provision of national parks and the preservation of the native plants and animals of Great Britain*.

(1) *National parks and national reserves*, of considerable size, open to and providing facilities for the recreation and enjoyment of the public with no more restriction than is necessary to preserve the amenities of the area. Their objects are various, but in general their purpose is to ensure to the people access to areas of wide appeal and to preserve these unspoiled for future generations. Such are typical mountain regions, moorlands and downs, stretches of sea-coast, fen-land, which have some peculiar interest because of their scenic beauty, their geological structure, their association with human history, their plant and animal life, and above all, their suitability for recreation and rest.

(2) Intermediate areas, which we may call *national wards*, "notable alike for their natural beauty and for their scientific interest and often including agricultural areas of great charm, in which all that is requisite for the preservation of their amenities is that they should not undergo any fundamental change". Such areas, and presumably only exceptional areas would be selected, would have to be delimited and preserved from unsightly or injurious industrial development, the operations of the speculative builder and the advertiser. Land in such areas need not be purchased from its owners; the essential is simply that present usage should be continued or should not be replaced by usages less in keeping with the peculiar charm of the place.

(3) *Nature reserves and sanctuaries*. These are areas to be set aside for a very special purpose, the preservation of representative samples of our native wild plants and animals, and of geological features of particular significance. They would include typical marsh and fen such as the Broads, beaches such as Blakeney, woodland such as the ancient pine forest of the Spey Valley, mountain and sea-cliff. Naturally, their special purpose would restrict their appeal to a limited section of the people, and the safety of the plants and animals would demand the least possible disturbance even by naturalists and the Nature-loving public; but the experience of the past, with its tale of the extermination and disappearance of native species, calls for the determined protection of wild life.

Of these three types of area the grandest in dimensions and in purpose is the national park, with its offer to the people of temporary release from the rush and strain of the daily round and of recreation of mind and body by contact with the peace and beauty of unspoiled Nature; and if national parks are to fulfil this object they must be made reasonably accessible to centres of population, and must have within easy reach, if not within their bounds, rest-houses where accommodation is comfortable and food inexpensive. The success of this part of the scheme will rest largely upon careful selection and subsequent planning. But even more will the success of the Nature reserves depend upon the proper selection of areas, for just as their purpose is specific, their locality must be defined by fine adjustment of environment to the needs of the wild inhabitants, plants or animals.

While the selection of the national parks and national wards, therefore, should be in the hands of a composite body including representatives of the Government Departments concerned, of bodies whose interests are in art and amenity, in touring and camping, and in wild life in its broader aspects, the choice of Nature reserves could be most fittingly made by scientific workers, especially biologists, familiar with detailed distribution and the conditions which influence particular species or assemblages of species.

The recent conference, the place and date of the meeting of which, curiously enough, are not mentioned in the Memorandum, made certain recommendations regarding the management of the areas. It suggested that the national parks and national reserves should be administered and managed locally "so far as may be desirable", a qualification which seems to leave the recommendation very much in the air. On the other hand, as regards the specialized Nature reserves and sanctuaries, the management "should be placed only in the hands of persons fully conversant with the highly technical problems included in the maintenance of the balance of life, and the general control should be vested in a central authority representative of the different interests concerned". Since no one has yet fathomed the intricacies of the reactions which make up the balance of life in any area, it may be difficult to constitute the "fully conversant" management committee. Indeed the great value to scientific knowledge of these ecological oases will be the opportunity they afford of continuous study under known conditions of the interplay of weather, soil, vegetation and fauna. How much that is required is indicated by the confession of the director of wild-life conservation in the United States: "the research undertaken in this country [U.S.A.] has never yet been great enough to meet the needs of conservation in any of its phases" (*op. cit.*, p. 243).

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* Nature Preservation in Post-War Reconstruction. Conference Memorandum No. 1. Issued on behalf of the Conference of the Society for the Promotion of Nature Reserves. November 1941.

So far as wild life is concerned, there are three broad principles which must guide the national park authorities to be created to determine general policy, if the report of the National Park Committee (1931) is followed. They are clearly set out by the Director of Fish and Wild-life Service in the United States Department of the Interior (*op. cit.*, p. vi). The first is that wild-life conservation is not an isolated problem but is inseparably linked with problems of soil, water and forest, and that all must be regarded together in a comprehensive policy. The second is that wild life must have an environment, animate as well as inanimate, suited to its needs if it is to survive. The third is that any use that may be made of any wild creature must be limited to the destruction of not more than the annual increase if the breeding stock is to be kept up, with the correlative that those animals and plants which are inordinately successful in the competition of life and tend to oust less robust neighbours must be kept ruthlessly within bounds. The successful sanctuary is not necessarily a place where *all* animals and plants are protected, for indiscriminate protection may well lead to the survival of the only species of plants or animals which need no protection, and to the consequent disappearance of the very forms for which a sanctuary was necessary.

It is unlikely that even the national parks, the areas of which are bound to be limited, will satisfy the craving for variety of scene and for the stimulus of unexpected prospects which is the inheritance of most men and particularly of such as the artist and the Nature wanderer. So that, with the formal reservations which have been mentioned, it behoves an enlightened Government to take further steps to preserve, and encourage appreciation of, the grander aspects of our varied scenery. A danger lies in the clash between business and Nature—the spread of industry to an unspoiled valley with perhaps the consequent pollution of miles of river and other deteriorations, the construction of ponded valleys in the Highlands as a source of electric power, entailing changes in the water supply of a watershed, the felling of great stretches of forest without compensatory planting. While no negative policy should be allowed to stand in the way of efforts which are to benefit vast multitudes of people, nevertheless a wise control would see to it that the benefits mentioned here were gained without serious disturbance to scenery.

It is sometimes forgotten that the great steps in the progress of civilization transformed the aboriginal landscape: the development of agriculture drained the marshes, destroyed the lowland forests, and replaced variety of vegetation by uniformity, just as the domestication of animals contributed further to the disappearance of woodland for the sake of pasture, and intensified the changes in plant life. What we now look upon as natural landscape is not the landscape of our forefathers, and it may be that the increasing comforts of civilization can only be gained by some sacrifice of aboriginal Nature. There is the more reason that further encroachments should be guided and localized, and that certain selected areas should now be set aside and should be preserved for all time as representative of the scenery and of the haunts of the wild life of the British Isles.

THE SCIENCE OF MERCERIZING

Mercerising

By J. T. Marsh. Pp. xv+458+56 plates. (London: Chapman and Hall, Ltd., 1941.) 32*s*. net.

WHEN cotton hairs are treated with a concentrated solution of sodium hydroxide in the cold, they combine with alkali and undergo a remarkable series of changes. The cellulose swells in such a way that the flattened cross-section becomes elliptical, with fairly complete disappearance of the lumen, and lateral swelling is accompanied by a decrease in length. Such phenomena, and the increased affinity for dyes of the alkali-treated hairs, as well as their increased strength, were first observed by a Lancashire chemist, John Mercer, in 1844–1850. After an interval of some thirty years, Mercer's observations were turned to practical advantage in the manufacture of crêpes, but the mercerizing process proper did not come into being until 1890, when a twenty-year-old chemist, Horace Lowe, discovered that cotton acquires a greatly increased lustre when the hairs are tensioned so as to prevent shrinkage during the caustic soda treatment.

As one of the most important processes in the cotton textile industry, mercerizing has occupied the attention of numerous research workers, especially during the past twenty years, and published work on the subject now exceeds in volume that on any other aspect of cellulose chemistry. Systematic studies of the changes in form undergone by cotton and related fibres in solutions of the caustic alkalis have been undertaken ; the mechanism of swelling has been elucidated, largely as a result of Neale's investigations ; changes in fine structure have been examined by X-ray methods ; and the properties of the mercerized product have been defined.

These achievements are, to a large extent, due to the awakening of the industrialist during the War of 1914–18 to the advantages which would accrue from the application of the scientific method even to such well-established processes as those of the textile industry. From the resulting activities of the private research laboratories, research associations and research workers in the universities, textile technology has been advanced from a state of simple empiricism to that of an exact science. The pace of recent advances in knowledge has been such that the man of science, having much to learn from the craftsman, has had little opportunity of collating his new-found knowledge in the form of text-books suitable for use by the student. Even now, most of the books in common use belong to the empirical age in textiles, and are unworthy of the new dignity of the subject. No such criticism, however, can be applied to Mr. J. T. Marsh's recent work on mercerizing. Out of his long experience as a research worker in the field of cellulose chemistry, he has compiled a survey of the literature of mercerizing which is both authoritative and interesting.

Commencing with a vivid account of the work of Mercer and Lowe, Marsh proceeds to discuss the growth and structure of cotton hairs and their dimensional changes in caustic soda solution, as a preliminary to a comprehensive account of mercerizing practice. This half of the book contains many illustrations of the beauty of the scientific method in textile technology, such as the proof that the swelling of cotton hairs in aqueous solutions of alkaline hydroxides depends on the degree of hydration of the alkali ion, and Adderley and Oxley's discovery that tables of doubling twists may be replaced by the simple rule that maximum lustre is obtained when the doubling twist is seven tenths of the original twist in the component yarns. The second half of the book is concerned mainly with the theoretical aspects of the action of caustic alkalis on cellulose. Neale's work on the swelling of cellulose, and Urquhart and Williams' studies of the moisture relations of mercerized cotton, receive exhaustive treatment in chapters which are among the most interesting in the volume. The methods which may be employed to assess the efficiency of the mercerizing process, and to identify causes of faults in the finished product, are discussed in the concluding pages.

In the main, the author has adopted the historical method in developing the different sections of his book ; no important paper fails to receive discussion, but undue space seems to be given to the now discarded work of early investigators. In addition, the reader is left with the impression that the author has had some difficulty in deciding the order in which the different sections of his subject should be treated. There are re-entrant points in the argument, and a more logical development might have been first to discuss the theoretical aspects of the action of caustic alkalis on cellulose, then the dimensional changes undergone by cotton hairs, followed by mercerizing practice and the evaluation of the finished product. Despite these defects, the book forms a most welcome addition to the literature of textile technology. It is particularly well illustrated, and besides being helpful to the research worker, should play an important part in the training of the future industrialist.

J. B. SPEAKMAN.

FUTURE OIL PROVINCES OF NORTH AMERICA

Possible Future Oil Provinces of the United States and Canada

A Symposium conducted by the Research Committee of the American Association of Petroleum Geologists, A. I. Levorsen, Chairman. Papers read at the Twenty-sixth Annual Meeting of the Association, at Houston, Texas, April 1, 1941, and published in the Association Bulletin, August 1941. Edited by A. I. Levorsen. Pp. vi+154. (Tulsa, Okla. : American Association of Petroleum Geologists, 1941.) 1.50 dollars.

THE authors of this symposium, in their review of possible additional sources of oil in Canada and the United States, are not concerned with the discovery of single fields or leases, nor yet with extensions of existing fields. Rather are they grappling with the problem of discovery of reserves in areas as yet only partly explored and in which there is every prospect of finding, not one pool, but many pools, sufficiently large to be of significance in assessment of the nation's total reserves.

The views expressed are for the most part not those of individuals, but represent the collective findings of committees appointed by various geological organizations to compile this inventory. There are, for example, contributions from the Rocky Mountain Association of Petroleum Geologists and the Pacific Section of the American

Association of Petroleum Geologists; also from the Geological Societies of Tulsa, West Texas, etc. Each of the nine articles contained in the symposium includes a description of provinces, in the region for which the authors are responsible, which have been selected as favourable from the point of view of future oil resources. Considered reasons are given for their selection, and beliefs substantiated by sketch maps and sections showing the general geography, structure and stratigraphy of potentially productive provinces. Moreover, to stimulate cohesion and enable the reader to frame an opinion of total reserves of this character throughout the United States and Canada, unexplored territory is critically reviewed from the point of view of four criteria considered, if present, as being favourable to oil accumulation. These are: areas of sedimentation, preferably marine, variable and unmetamorphosed; seepages; unconformities; and the known presence of wedge belts of porosity.

A map depicting regions of possible future oil provinces as described in the symposium indicates that approximately two fifths of the total area of the North American continent falls into the category of potentially favourable territory. It is refreshing to visualize the magnitude of unexplored reserves in this way rather than to be faced, as one so often is, with quantitative estimates of potential reserves running into billions of barrels and having little claim to accuracy. Surely the bugbear of the industry, fear of exhaustion of resources, will loom less large when it is realized that there are such vast areas of untried territory. Calculations of reserves cannot properly be made until geologists have completed the almost limitless task of exploring such mighty terrains as are described in this symposium. Even then, no claim could be laid to have exhausted possibilities of new resources in these two countries.

CANADIAN ARCTIC BOTANY

Botany of the Canadian Eastern Arctic

Part I: Pteridophyta and Spermatophyta. By Nicholas Polunin. (National Museum of Canada, Bulletin No. 92.) Pp. vi+408. (Ottawa: King's Printer, 1940.) 1 dollar.

WORK on the flora of the Canadian Eastern Arctic has been dogged by misfortune. James M. Macoun, chief botanist of what is now the National Herbarium of Canada, made several expeditions into the western part of the area, collecting a wealth of material, but died before his father in 1910. His prospective collaborator, Theo. Holm, had in 1902 promised at an early date a work on the Hudson Bay flora, but died before he completed it. Thorild Wolff died in 1917 crossing the extreme north of Greenland before he reached the area he chiefly set out to explore. M. O. Malte, successor to Macoun as chief botanist at the National Museum, in 1927 began work in earnest in collaboration with C. H. Ostenfeld, director of the Botanical Garden, Copenhagen, a well-known specialist in the Arctic flora. Ostenfeld died in 1931 and Malte in 1933, but during these few years Malte made three voyages in the Canadian Eastern Arctic, collecting more than ten thousand sheets of specimens.

The field therefore lay open ready for Nicholas Polunin, a young botanist with a bent for Arctic travel, who in 1930, when a college student, made a botanical trek across Arctic Norway and Lapland; in 1931 as botanist to the Oxford University Expedition investigated Akpatok I. (Labrador); and in 1933 alone crossed and recrossed Spitsbergen in 2½ days. In 1934, on the Hudson Bay Company's supply ship, he visited all the more important northern ports in the Eastern Canadian Arctic, and in 1936 made a similar voyage with the Eastern Arctic Patrol. From autumn 1935 he had spent more than a year revising all the Arctic material in the Gray Herbarium of Harvard University, and in some Canadian museums. The Canadian authorities, finding so much work already done, offered their support if Polunin would complete, for them to publish, a flora of the Canadian Eastern Arctic, of which, after more than two years' further solid work, the volume before us is the first part. Parts II, "Thallophyta and Bryophyta", and III, "Vegetation and Ecology", are ready for printing, and Part IV, "Subarctic Regions", is well advanced. The Canadian authorities deserve thanks for producing this useful volume in these difficult times, and it is hoped that the remaining parts will appear with as little delay as possible, for the systematic keys for the identification of the flowering plant species—greatly needed by students of the Arctic flora, who at present are forced to acquire the necessary knowledge by laborious and time-consuming delving in an extensive and scattered literature—were relegated to Part IV, as that part would include a much greater number of species, some of which will probably be discovered in the area covered by the present volume.

As it stands, however, this work will be invaluable to students, since it collates all material from the area in fourteen American and European institutions, which together house the greater part of the specimens ever collected there, and in addition provides an extremely full bibliography of the literature, which has been thoroughly digested by the author. The work is not, however, a dull compilation of already published material. Polunin has himself revised all identifications, and in addition contributes to the account of individual species valuable notes resulting from his own field observations and herbarium study. As a result, the book is full of useful and interesting information, not only taxonomic but also ecological and miscellaneous. All doubtful records have been investigated, and when species have been excluded the nature of the error is exposed as fully as possible.

The introduction begins with the geography of the area, which includes "all land in Canada lying north of the 60th parallel of latitude and east of longitude 95 degrees west, with the exception of Axel Heiberg Island, Boothia Peninsula, and the inland parts of Keewatin". For the grouping of individual records, this area is divided into ten districts: Ellesmere; Devon, Cornwallis, and Somerset Islands; Northern Baffin; Central Baffin; Southern Baffin; Melville Peninsula; Northernmost Labrador; Northern Quebec; Islands in Hudson and Ungava Bays; West Coast of Hudson Bay (Keewatin). The boundaries of these districts are shown on a sketch map in the text, but not on the larger map supplied, and unfortunately the authorities did not see their way to arrange for the insertion on the latter of the numerous localities mentioned by collectors on labels, although the inclusion of these would have greatly increased its value. The difficulty of tracing place-names so used without any indication of their whereabouts—such as 'Shift-rudder Bay', 'Floeberg Beach'; 'Dumbbell Harbour', and the like—is here solved by the inclusion (pp. 3–11) of the latitude and longitude of almost all such localities. The necessity of this is shown by the fact that even when such essential names as Baffin Island are counted, less than two-fifths of the names in these lists are shown on the map, and it is to be hoped that the authorities will reconsider their decision and issue a more satisfactory map with a subsequent part.

The second part of the introduction gives a brief summary of the "History of Exploration" in the area, and includes an alphabetical list of collectors with dates and localities, extremely useful to workers in herbaria. An undeserved slur is cast on Robert Brown, of whom it is said that he, "in compiling a botanical appendix to Ross's report (1819), 'lumped' the Greenland plants with those of our area, so that with a few exceptions I am unable to cite them." Robert Brown was a most meticulous worker, and the 'lumping' was due to the fact that for the most part the specimens—now in the British Museum—apparently never had any indication of the place where they were collected. It may even be that Robert Brown made such strong comments on this that the specimens collected on Parry's voyages a few years later were precisely localized, for in those days it was commonly considered that a very general indication of locality was sufficient.

Except for the acknowledgments of help, the remainder of the introduction deals with the plan, scope, and methods of the catalogue itself. The author estimates that he has examined and determined between fifty thousand and sixty thousand records. He writes: "It will be noted that my conception of species is rather broad—that I tend to be a 'lumper' rather than a 'splitter'. My varieties are the subspecies of some authors, and even the microspecies of others—entities which in possessing several 'characters' of distinction from the rest of the species, and in having a geographical distribution of their own, are 'on the way to becoming species'." (It may be remarked that these features, namely, correlation of distinct characters and a distinct distribution, are precisely those which I have frequently insisted on as being the twin essentials of specific difference, and these groups are better termed subspecies.) "My *formæ* are entities which, in our own state of ignorance concerning the genetics and cytology of most groups, are assumed to be of lesser taxonomic significance. They are often striking enough in their differences from the typical . . . form, at least in the apparently less conservative characters, but still are presumably mere phases, which lack on the one hand a real *group* of hereditable characters, and on the other a geographical range distinct from the rest of the species." (The term *variety* would be more appropriately applied to such still unresolved *variations*.)

All critical groups have been investigated by the author himself, a course possible in dealing with the reduced flora of the Arctic regions. Although the order and nomenclature are in general those adopted in the Gray Herbarium, Polunin has preferred to investigate these matters for himself, rather than to adopt them without question. The care with which both kinds of investigation have been conducted is shown throughout the volume by the usefulness of the notes which embody these researches.

The catalogue itself comprises 297 species, of which four are new, and a total of 399 named forms, including ten new varieties and nine new forms; most of the novelties are illustrated. Of all these, not one appears to have been introduced by the agency of man, although the area dealt with is some 420,000 square miles of land. Man is, however, a rarity in these regions. Of the 297 species, nearly two hundred occur also in the European Arctic, and between eighty and ninety in Britain. The severity of the climate of this part of boreal

America is indicated by the fact that in Europe north of the 60th parallel more than a thousand species occur, and even in Greenland about four hundred species are known.

Each species in the catalogue is dealt with in a uniform manner. The name is followed by only such important references and synonyms as are required for identification, the rest of the nomenclature being obtainable through the index. Then follows, in most species, "a discussion of the systematic position, with special reference to the range of variation that it exhibits in or near our area; also, when possible, notes on its morphology, flowering and fruiting, and on any other features of special interest."

These discussions of taxonomy and variation are much more informative than the usual bald citation of names in synonymy, and the readable and vivid style in which they are written is more likely to impress the information on the mind than the stereotyped frigidity which is nowadays so often considered to be required in scientific publications. For example, of *Carex bicolor* All. (recently recorded from the Outer Hebrides), "This most characteristic and attractive little sedge, with its more or less pendulous spikes of rounded, pastel-green fruits peeping out from behind dark scales, although not uncommon in places, appears never before to have been recorded from within our area, or, indeed, from anywhere in the Arctic Archipelago . . . ; also *Lycopodium Selago* L. . . . it is reported by Victorin of this species that 'toutes les tribus sauvages du littoral de l'Alaska mâchent les tiges en avalent le jus pour produire une sorte d'intoxication'; but I can neither find any confirmation of this in the literature or by enquiry from travellers in the region, nor obtain any such effect on myself. Certainly the Eskimo of the Eastern Arctic regions do not use it or any other plant in this manner; indeed, except for the occasional dressing of wounds with *Sphagnum* and the use of various plants both higher and lower for food (generally quite irregularly; they will eat almost anything at times), they do not seem to apply any plants or plant products to their bodies either internally or externally, in marked contrast to their Indian neighbours. . . ."

After these notes the "General Distribution" of the species outside the area is given, followed by the "Eastern Arctic Distribution", or general distribution within the area. Then, under "Occurrence", come "details of the relative abundance of the species in the various parts of its range in our area; also notes on its habitat and ecology, and on its importance as a component of the vegetation. [The ecological notes are mainly based on the author's own observations.] The consideration of each species is concluded by the detailed citation, under the ten major districts headings mentioned . . . of the specimens of it that have been found within our area, or, in the case of the commoner plants, by generalized statements under the same headings."

In the detailed citation of records in critical groups, including as it does indication of the herbaria in which specimens exist and of previous identifications, lies one of the great values of this work. For until the end of last century the existing material was generally scanty and widely scattered, the literature equally so, and consequently identification, especially in critical genera, was frequently very unsatisfactory, wherefore systematists using herbarium material as a basis for their own determinations were often misled and the already existing confusion became worse confounded. Robert Brown, pioneer in the field, working out the results of the first of Parry's voyages, of which his "Chloris Melvilliana" still stands unshaken as the foundation of the literature of the American Arctic, worked with such care that Parry, anxious to obtain quicker determinations to include in his report for the Admiralty, became impatient, and sent the material of his subsequent voyages to W. J. Hooker. Hooker, who was not, as a critical botanist, of the calibre of Brown—*botanicorum facile princeps*—"lumped" together the species of critical genera. From this it followed that, in precisely those genera where the need for well-named material was greatest, herbaria normally contained different plants mixed under the same name, until it was unfortunately too true, as Dr. J. Lid of Oslo once remarked to me, that most Arctic collections were very badly named, and require thorough revision by a specialist in the Arctic flora. This revision has now been admirably made for the Eastern Canadian Arctic. The debris of the past has been cleared up and a good foundation for the future laid down. In an area so extensive a great deal must still remain to be done, but a much-needed work has been accomplished.

One may disagree with the treatment of certain genera or species. My own experience convinces me that the Arctic Cochlearias are not all one species; but every student of this difficult genus seems to produce a different solution of its undoubted intricacy. The "*Zostera marina*", isolated in Hudson Bay in water "probably almost always below 10 C.", is more likely to be the more boreal *Z. Hornemanniana* Tutin. But specialists will be able to criticize any comprehensive work for yet a long time to come, and the present volume certainly calls for compliment on its general soundness rather than criticism in detail. It remains but to add that it is well set out, well printed (with few misprints), and very thoroughly indexed.

A. J. WILMOTT.

Herbs for Daily Use in Home Medicine and Cookery

By Mary Thorne Quelch. Pp. 328. (London: Faber and Faber, Ltd., 1941.) 8*s.* 6*d.* net.

THERE are here numerous pleasant anecdotes of the useful plants of our islands, culled from authorities both ancient and modern. The range is from Dioscorides through the herbalists—Gerard and Culpeper especially—to a gypsy woman "whose herbal lore I shall quote many times". This promise is amply fulfilled. There are recipes for unusual dishes and cosmetics. Among the former "the boiled nettles, as described, may be surrounded by poached eggs". Among the latter, to prepare a cold cream, "if two ounces of glycerine are purchased". Alas, 'tis "if" indeed. The bulk of the book is concerned with medicinal purposes. As it is for the home, safety is wisely put first and the drug plants of the pharmacopœia are dismissed under the entry "poisonous plants". The use of the yellow flowers of celandine as a cure for jaundice is derided as an example of the doctrine of signatures; but, on reading later that beetroot is "of value to anæmic women and girls", you wonder if the superstition is so dead after all. Old wives' simples may be traditionally mated with old wives' tales, but they include (p. 272 under review) raspberry-leaf tea as an aid to easy labour, a prescription which has recently been lifted into official respectability. Here is a good half-hour's browsing to be taken over the nuts and wine.

Butterflies

A Handbook of the Butterflies of the United States, complete for the Region North of the Potomac and Ohio Rivers and East of the Dakotas. By Prof. Ralph W. Macy and Prof. Harold H. Shepard. Pp. vii+247. (Minneapolis: University of Minnesota Press, 1941.) 3.50 dollars.

THIS handbook forms an admirable short guide to all species of butterfly inhabiting the region it is intended to cover. The area in question includes the United States and adjacent Canada lying to the east of Nebraska and the Dakotas and as far south as the northern borders of Missouri, Kentucky and Virginia. The only other book that treats in any detail of the butterflies of the territory referred to is the large, expensive and long out-of-print work of S. H. Scudder.

The chief purpose of the present book is to make identification as easy as possible. Keys to the species of each family are followed by individual descriptions, notes on habits, on distribution, on the larva and its food plants, times of appearance, manner of flight and so forth. The collector will consequently find a good deal of information written in an attractive style and in a brief, concise form. The book should have a ready sale among individuals, secondary schools, and colleges of the United States and parts of Canada. The price is very reasonable considering there are four good-quality coloured plates and a number of photographic text-figures. A. D. I.

British Scientists

By Sir Richard Gregory. (Britain in Pictures Series.) Pp. 48+12 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1941.) 3*s.* 6*d.*

THIS little book puts in the simplest possible way some of the facts about the life and work of the great British men of science. Though containing only fifty pages, it is illustrated with twelve coloured plates and nineteen other illustrations. It is the sort of book which might be distributed in large numbers to soldiers and other large sections of the population who wish to know something of those who have had, it is increasingly realized, a most profound influence on the destiny of the human race. The book should also be suitable for readers in foreign lands, who are hazy about the existence and achievements of British men of science.

The information in the book will generally be known to scientific workers. They may not, however, have seen before coloured reproductions or the originals of several of the illustrations. For example, the picture of the third Lord Rayleigh working in his shirt sleeves in his laboratory is reproduced in colour. Then there is the painting from the University of Birmingham of Sir Oliver Lodge; the long, red doctor's robe, emphasized by his great height, comes out brilliantly. In black and white, there is Francis Dodd's drawing of Rutherford.

There are some misprints in the list of dates given at the end. These might be corrected in future editions. J. G. CROWTHER.

Physics of the Air

By Dr. W. J. Humphreys. Third edition. Pp. xiv+676. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 42*s.*

THIS book has reached the status of a classic of meteorology; the few weaknesses of the first edition having been for the most part remedied in the second, the third edition needed little more than bringing up to date by the addition of references to the advances of the last ten years. These additions have necessitated the writing of a number of new paragraphs, notably on the effect of clouds on incoming and outgoing radiation, energy equations of evaporation, and zones of silence in meteorological acoustics, the latter remedying a serious omission in the second edition, while throughout the book existing paragraphs have been expanded to take in work published up to 1939. In a few cases the additions are disappointing; for example, the subject of air-mass identification was surely worth more than a half-page, and the "principal Ice-age theories" do not include the well-known solar pluvial theory associated with the name of Sir George Simpson. As a whole, however, the book remains equal to its expressed purpose of providing an orderly assemblage of facts and theories, equally valuable as a text-book for advanced study or a work of reference on a meteorologist's shelves. One unfortunate misprint has crept into the list of contents, where atmospheric refraction has been included under "Reflection phenomena".

The Second Yearbook of Research and Statistical Methodology :

Books and Reviews. Edited by Oscar Krisen Buros. Pp. xxi+383. (Highland Park, N.J.: The Gryphon Press, 1941.) 5 dollars.

THE second issue of this Yearbook maintains the high standard of the first issue, covering the years 1933–38. Being greatly enlarged, it exhibits more fully the advantages of this original method of gathering in a single work of reference the critical and descriptive reviews which have appeared upon the literature in this branch of science. The excerpts presented in this Yearbook are longer and more informative than those in the first volume. The material covered has been extended, especially in mathematical economics, population studies and general histories of science. The appearance of the volume has been improved in many ways, including the use of larger type, and, although a work of this kind was particularly needed in respect of statistical methodology, the value and convenience of this venture should encourage the application of the same principles with respect to other branches of scientific literature.

Within the field with which the reviewer is most familiar, the excerpts from reviews have been made judiciously, and adequately represent the point of view and critical contributions of the reviewers, in addition to giving indirectly a good idea of the works noticed.

Since review notices are particularly liable to be scattered and inaccessible, it is a very great convenience to have them collected, reproduced, and well arranged. R. A. F.

An Introductory Course in College Physics

By Prof. Newton Henry Black. Revised edition. Pp. viii+734. (New York: The Macmillan Company, 1941.) 3.75 dollars.

THIS is a revised edition of the author's "College Physics" first published in 1935. The course is one which would suit most schools, though the author had in mind the needs of definite types of students. In this connexion, there is a slight bias towards physiology and medicine. Also it is pleasing to note that consideration is given to those students studying physics for the sheer joy of it, not with the view of taking any special examination; hence many applications to modern machinery and household devices are included.

Throughout the book emphasis is laid on fundamental laws and principles, and theories are introduced only in so far as they seem helpful in understanding significant facts. There is a good selection of numerical examples graded in difficulty, and the many labelled diagrams are very good; such diagrams are most helpful to students, and they save much descriptive matter.

The book runs to 734 pages, and a lot of ground is covered, but one feels that in some cases more should have been made of certain topics. For example, in view of the great importance of sound in modern applied physics, this section is rather thin; in a book covering the whole field of elementary physics, however, it is obviously impossible to treat all the subjects fully. The book is very well produced, and it is certainly a most useful addition to school physics books.

Intermediate Electricity

By Robert W. Hutchinson. Pp. viii+628. (London: University Tutorial Press, Ltd., 1941.) 12*s.* 6*d.*

THIS book is intended to replace the author's well-established "Text-book of Electricity and Magnetism", and it must be said at once that it is an exceedingly useful book.

The treatment is on modern lines, and a pleasing innovation is an introductory chapter on the modern theory of electricity and electrical phenomena; here the facts are stated simply, and they form a useful background for the student's future work. Another pleasing feature is the stress laid on the fact that magnetism itself is merely a phase of electricity, and it is refreshing, though unusual, to find the topics of terrestrial magnetism and atmospheric electricity discussed in the same chapter.

There are numerous fully worked examples; this is a good feature, especially for those students working alone. Emphasis is also rightly laid on the importance of units; neglect of this work often leads to confusion when students tackle numerical problems. The author does not set out to cater for any particular examination, but the book more than covers the needs of those students preparing for the Intermediate Science, Higher School Certificate and Scholarship examinations. The mathematics in the book should be well within the compass of these students, though the average student may find the mathematics in the chapter on alternating current and varying currents rather formidable.

In spite of its rather high price, the book is excellent value, and if a student can afford it he will find it extremely helpful and useful.

Handbook of Economic Entomology for South India

By Dr. T. V. Ramakrishna Ayyar. Pp. xix+528. (Madras: Government Press, 1940.) 4.12 rupees.

KNOWLEDGE of South Indian insects has greatly increased since the publication of T. B. Fletcher's book on the subject in 1914. This work is now out of print and there is a growing demand for its replacement by a more modern book. As a desideratum it has been filled by the appearance of Ramakrishna Ayyar's volume that is now before us. This writer is very well qualified for the task, having many papers and bulletins on South Indian economic entomology to his credit. The book is divided into two parts, and Part I deals with general aspects of the subject such as anatomy development and classification. Part II is in the main a conspectus of the chief injurious insects of South India and the best-known methods for combating them. The book is well printed and seems to be very free from errors, while its numerous illustrations add materially to its value. It should meet with a wide and speedy acceptance and fill a definite place in the literature of Indian economic entomology.

ANGLO-AMERICAN CO-OPERATION IN SCIENTIFIC RESEARCH

By PRESIDENT JAMES B. CONANT, For. Mem. R.S.

THE following address by President James B. Conant, of Harvard University, was arranged to be given on September 26 before the Conference on Science and World Order, under the auspices of the British Association for the Advancement of Science, in London. The address was made on a record in Washington and flown across the Atlantic for rebroadcast to the Conference. Unfortunately, it failed to arrive, but the following copy has recently reached us.

I assume that through the United States Ambassador, Mr. Winant, you have asked me to address you because of the fact that I am chairman of the National Defense Research Committee, an arm of the United States Government. In that capacity, it is perhaps fitting that I should have something to say about the mobilization of science in the United States and the co-operation of British and American men of science for the war effort. On the other hand, many things that I have said as a private citizen of the United States concerning the foreign policy of my country would be entirely inappropriate in this address. To some of you my views are known. I can only say that I hold them with greater conviction every day. Many of my fellow men of science and academic colleagues on this side of the water are of the same opinion—others have disagreed. That a great debate has raged in the United States about the extent and nature of our participation in the war against Hitler will be no surprise to a British audience. For if I read your recent history rightly, it was not a matter of weeks or even months, but rather of years before the citizens of your country were able to resolve the deep conflict between the ideal of peace and the ideal of freedom, between their hatred of war and their hatred of the Nazi philosophy of tyranny and fear. For I take it these were the elements which determined the development of your own foreign policy before the War.

But in one matter I can brush aside all harassing ambiguities. On one point all American men of science are agreed. They unite in saluting the bravery of the British nation; they applaud unanimously your gallant stand. Moreover, as scientific workers they are proud of the vital parts their fellow-workers of Great Britain are playing in the struggle now in progress. They realize, though often only dimly, that history will surely record this heroic struggle as a defence against overwhelming odds not only of Great Britain but also of individual liberty throughout the world.

In June 1940 the first realization of a world crisis aroused the United States. Amidst violent debates on foreign policy, a vast programme of rapid rearmament was initiated. As to the necessity of producing at top speed a great quantity of instruments of war there could be but one opinion. In these circumstances it was essential to mobilize the scientific talent of our country with all haste. The National Defense Research Committee, with Dr. Vannevar Bush as chairman, was then created by Presidential order. Its task was not advisory, for the scientific advisory bodies of the Government had long been in existence. The National Academy of Science, a parallel of your Royal Society, has by Congressional charter the duty of advising the Federal Government on scientific matters. The National Research Council, a creation of the Academy, has functioned effectively to that end for many years and still continues to play an active part, particularly in the field of medical research. What was needed was not another advisory body but an executive agency capable of bringing available scientific talent as soon as possible in touch with the army and navy; an executive agency to speed up the scientific research on instrumentalities of war by drawing on the existing laboratory facilities of the whole country. This was the function the National Defense Research Committee was created to fulfil.

The new Committee was composed of six civilians together with a representative of the Secretary of War and a representative of the Secretary of the Navy. Rather than establish any large organization of its own, the National Defense Research Committee decided to use its available appropriations through contracts with universities and industrial firms which would carry on specific research and development on secret matters pertaining to modern warfare. Through various sub-committees or divisions, each headed by a Committee member, the work was soon divided. To my lot fell chemistry, to Prof. K. T. Compton, of Massachusetts Institute of Technology, fell one branch of physics, to Jewett and Tolman were assigned still others. Liaison officers from the Army and the Navy were attached to the various sub-committees. In this way the men of science brought into the new work were kept in active touch with members of the Armed Forces.

During the past year, more than ten million dollars have been spent through 270 contracts placed with 47 different universities and technical colleges and 153 contracts placed with thirty-nine industrial firms. Needless to say, great precautions have been necessary to insure the secrecy of the work. No man has been brought into the organization either as a member of a sub-committee or as a contractor without the approval of the Army and the Navy. Great care has also been taken to ensure secrecy in the placing of the contracts either with academic workers or industrial firms.

In both physics and chemistry the effort has been to distribute so far as possible the problems to different investigators throughout the country. In this way, during the initial year at least, the normal functions of our universities were, so far as possible, undisturbed. In a few cases the nature of the work has made such an arrangement quite impossible. In one case in particular, the Radiation Laboratory at the Massachusetts Institute of Technology, it was essential that a large group of physicists should be assembled to work on a highly confidential and important subject with the greatest possible speed. Therefore, more than 150 different physicists from twenty-five different universities in all parts of the country have been brought together to work towards a common goal. We estimate that approximately a thousand scientific workers, ranging all the way from senior professors to young research workers, are now at work in one way or another in academic institutions under contracts with the National Defense Research Committee. In addition, more than seven hundred scientific workers of the same grades are at work in industrial firms in connexion with the contracts which have there been placed. As in your own country, we have found that the nature of the problems in this War are such that physicists and certain types of engineers are in greater demand than chemists. Indeed, it would appear from a survey that has recently been made that probably 75 per cent of the more distinguished research physicists of the country (those starred in the "American Men of Science") who are available are now at work on war problems. I hazard the opinion that it will be only a few months before the remaining 25 per cent are equally involved.

The success of the undertaking has been due in no small measure to the effectiveness of Dr. Vannevar Bush, both as a man of science and as an administrator. Dr. Bush was the chairman of the Committee during the first year of its existence and shouldered the responsibilities for the enormous task. Three months ago, by order of the President, he was made director of a newly created Office of Scientific Research and Development. In this capacity Dr. Bush was charged not only with many of the responsibilities which he had formerly carried as chairman of the National Defense Research Committee, but with the further task of co-ordinating scientific research on medical problems affecting national defence. Most important of all, he has the charge of co-ordinating, and where desirable, supplementing the scientific research activities carried on by the Departments of War and Navy and other agencies of the Federal Government. The National Defense Research Committee now becomes a part of the new Office of Scientific Research and Development, and I, as the new chairman, am responsible to Dr. Bush.

Parallel to our Committee is a newly formed one on medical research, of which Prof. Alfred N. Richards is chairman. Together these two Committees will be the main instruments which the Office of Scientific Research and Development will use to carry out the task entrusted to it by order of the President of the United States.

Such, in brief, is the organization which has been created to bring about the rapid mobilization of scientific talent in the United States to aid the Armed Forces of the Federal Government. Those who are interested in problems of organization and administration will note that the scheme is both flexible and temporary. It is clearly designed to last only during the period of national emergency. No new permanent organizations are created, no new Government laboratories are built or staffed, no large administrative offices are established. Rather a method was devised by which with all speed possible the available scientific talent and available laboratories of the country could be used to supplement the already existing research establishments of the Army and the Navy.

One of the happiest results of the past year's labours has been the ever-increasing Anglo-American co-operation in scientific fields. This was at first made possible on our side of the water by the National Defense Research Committee; it is now a function of the new Office of Scientific Research and Development. The Executive Order which established this office with Dr. Bush at its head provided that the Director should initiate and support such scientific research as may be requested by the Government of any country the defence of which the President deems vital to the defence of the United States under the terms of the Lease-Lend Act of March 11, 1941. As many of you know, we have had in London since last March American scientific liaison officers, Mr. Hovde and Mr. Lewis. It was my privilege to come to England with Mr. Hovde and to initiate the exchange of research information on instrumentalities of war. From the first moment of our arrival, we met a cordiality and openness of welcome that made evident your whole-hearted interest in co-operation. I trust the British representatives in Washington have formed a similar opinion of the American attitude.

After more than six months of work our interchanges of information and of workers have yielded results of considerable importance. I believe that we on our side of the Atlantic have contributed something to your great effort, and I hope and pray that our contribution before many months are past will be of the first order of importance; for I know I am speaking for my fellow-workers in the National Defense Research Committee when I say that nothing would give us more satisfaction than to feel that through our work we had contributed directly to the effectiveness of the war effort. Our eagerness to help can scarcely be over-estimated; may the future demonstrate that our capacities have been equal to our desires!

I cannot conclude without referring briefly to what must be to some extent in everyone's mind at this Conference—the world we are going to live in after the War is over. It is not for me to outline a world order or even to express views on Anglo-American policy. But no intelligent man who on one hand loves peace, and on the other places the highest value on individual liberty, can doubt that without some form of co-operation between our two countries no peace worth fighting for can be established. Similarly, no intelligent man who consults his head as well as his heart can fail to note great obstacles that stand in the way of effective co-operation and collaboration. It should be the duty of all trained thinkers, particularly men of science, on both sides of the water, to study these obstacles coolly and impartially. For only by knowing their nature may we hope to overcome them. Only by dispassionate study may we hope to reduce these barriers.

I say particularly men of science, for they realize more than many others the potentialities that lie hidden in the future. Men of science realize as many cannot the extent to which modern technology has diminished effective distances around this planet. They know, too, that the end of this revolution in transportation is not yet in sight. The world contracts before their eyes. To them dreams of new adventures and new conquests of the material universe wait for realization only on the sustained labour of free men. To-day, the men of science of Great Britain and the United States are working almost as one group with the purpose of improving instruments of war. Is it fantastic to hope that in the not too distant future the men of science of all free countries may be joined in effective action to improve, not instruments of war, but those of peace? I like to see in the present scientific liaison that runs through the centre of London, Ottawa and Washington a hopeful omen of a long period marked by the friendliest relations between the British Commonwealth of Nations and the United States. If this be so, our work foreshadows a time when professional talent in many diverse societies of free men will strive for effective co-operation to the end that we and our children may walk boldly along the paths of liberty and peace.

AGRICULTURE AFTER THE WAR

By SIR JOHN RUSSELL, F.R.S.

Director, Rothamsted Experimental Station

THE invention of the submarine has profoundly affected the development of British agriculture, bringing it out of its accustomed obscurity into a very high position both in the War of 1914–18 and in this War. British peace-time dietary is more varied and effective than that of any other country in Europe, but it requires so much land for its production—on the average some 1·6 acres per person—that the total area of agricultural land suffices only to provide 40 per cent of the nation's food. The remaining 60 per cent has to be imported, and it was brought in from almost all quarters of the world. This method of feeding the nation postulates peace and the smooth working of international trade, and it breaks down in war-time. Home production then becomes much more important, and the national dietary is changed so as to make less call on the land; in place of the 1·6 acres of peace-time, the aim is to get nearer to the 1·1 acres that suffice for the German dietary. Further, there is widespread recognition that British agriculture is a major industry, and that unless it is sufficiently prosperous to attract and retain a vigorous and intelligent body of farmers and farm workers, there will always be trouble in the country-side. Under the chastening influence of war, politicians and writers become very penitent about their past attitude to agriculture and full of good resolves for the future.

We are somewhat in this position now, and we passed through the same phase in the War of 1914–18. Then it was resolved that British agriculture really should be developed, and wages boards were set up to impose a minimum wage which would ensure the workers' efficiency and do away with the hardships which some of them had suffered. Prices were to be at such a level that these wages could be paid.

There arose the difficulty that has always proved oppressive and for which no satisfactory remedy has yet been put into operation. Agricultural produce can be raised very cheaply by peasants in almost any country in Europe and by farmers using ranching or other 'extensive' methods in some of the new countries, and trading organizations can collect it and bring it to our markets at very cheap rates. The peasant is, of course, poorly paid, but his standards are low, and the 'extensive' methods may be harmful and even destructive to the soil; but they answer for a time. In other producing countries where sound intensive methods were used, special arrangements were often made on the home market so as to enable the commodity to be sold cheaply on the English market. Finally, whenever a specially bountiful harvest had provided a large excess over the usual supply, this was put on to the British market as being the only one that would take it. In consequence the prices of agricultural produce here had no relation to the cost of production on farms in Great Britain, and moreover they were quite unpredictable, so that British farmers had no idea when they sowed their crops what prices they would receive for them. The only exceptions were milk and potatoes, of which there was little or no import, and a few commodities such as high-quality meat, malting barley, seeds and certain fruits and vegetables, for which a special demand existed.

For the rank and file of the farming profession there was no security, and most farmers adopted the traditional safeguard of laying down their land to grass and cutting down all expenditure; thereby reducing the outgoings to the point at which returns, though also greatly reduced, would balance them. Farmers put up the best fight they could; they lowered costs of production by reducing the numbers of their workers but increasing the output per head from the survivors, so that finally the average output per worker was equivalent to the feeding of seventeen persons, this being higher than in any European country. Some farmers went in for considerable mechanization, but this had its disadvantages. On one farm the new system reduced the cost of wheat-growing by nearly half. But while on the old system the farm had produced 630 cwt. of meat per annum, on on the new one it produced none. Much more serious: on the old system forty men had been regularly employed, on the new one only four were needed and the remaining thirty-six were 'released': and of these, twenty-two became a charge on public funds. Obviously one-sided arrangements of this sort are not desirable. The fall in area of arable land became so serious that steps had to be taken against it: these were in the nature of contracts, and unfortunately were called subsidies.

All history shows that British agriculture cannot stand up against the unrestricted imports of foodstuffs at low prices, and if farmers are left to solve the problem unaided no better way has yet been found than lowering the level of agricultural operations. It can safely be assumed that this same difficulty will arise after the present war, and that the same method of coping with it will be adopted unless a better one has in the meantime been adopted.

Fortunately a number of people are trying to design alternative solutions. During the War of 1914–18 it was thought that small holdings would solve the problem: the small man, it was said, would work with greater economy and be content with less reward than the large farmer and so might survive. But he did not, and although many small holdings were set up, an even larger number closed down, so that this solution does not appear to be general. Clearly some new proposal is now needed, and Sir Daniel Hall supplies this in his latest book*. He advocates large units, which would mean so much regrouping of the land, alterations of buildings and redistribution of implements and stock that the present landowners could not possibly undertake the task. He therefore suggests that the State should purchase the whole of the agricultural land of the country, that a commission should cut it up into units of suitable size, provide appropriate buildings and carry out the reclamations necessary, then hand the finished farms over to the Commissioners of Crown Lands, who would pass them on to land agents, who would let them to farmers. The proposal will certainly receive the serious consideration which Sir Daniel's distinguished authority requires.

An important reason for the failure of the promised development of agriculture after the War of 1914–18 was that no decision was ever reached as to the part that agriculture should play in the national life.

The prime need in any agricultural policy is to decide what proportion of our different foods we should aim at producing; and from what countries and in what amounts we should draw the foods that we propose to import. As the largest buyers of agricultural produce in the world, we are in a position to exert a very potent influence on post-war economy in a large number of countries, and our influence will be good if we work out a proper plan and stick to it.

Whatever agricultural systems are adopted the contract price method is essential now that wages are fixed by agricultural wages boards without reference to prices of produce. When adequate prices are assured it becomes possible to decide whether we should continue the classical system in which about 50 per cent of the arable land is in grain, 25 per cent in temporary clover and grass leys, and 25 per cent in root crops and potatoes, proportions which held generally right up to the War, or whether some more intensive systems should be adopted, such as that recommended by the Astor-Rowntree group, in which farmers aim at high quality and what one might call high potential: the protective foods, milk, fruit, eggs, vegetables and high-quality meat. These gain in value by being fresh, that is, by being produced locally: they employ more people per acre and give a larger output per acre than other kinds of produce.

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* Reconstruction and the Land: an Approach to Farming in the National Interest. By Sir A. Daniel Hall. Pp. xi+287. (London: Macmillan and Co., Ltd., 1941.) 12*s*. 6*d*. net.

Account must also be taken of the part that agriculture can play in solving social problems such as unemployment and the rehabilitation of the unfit, and also of the vitally important problem of safety in war-time.

Science must always play an important part in agricultural development, though it needs careful management because of the wide difference in outlook between scientific workers and agriculturists. Agricultural operations are so dominated by weather and by other disturbing factors, including pests and diseases, that no rigid rules can be laid down. An experimental result can never have quite the same validity as in a chemical or physical laboratory. It may always be profoundly affected by some wholly unexpected and perhaps unobserved factor, and until it has been confirmed over a wide range of conditions it is liable to the suspicion that it may be abnormal. When all results are assembled they can be subjected to statistical analysis and an average obtained with its appropriate standard error, but it may not apply on any particular farm even though over a hundred farms it might hold good for a majority. Frequently the farmer has arrived at a general fund of knowledge about his own farm, which he is reluctant to disturb except on very convincing evidence. 'Good husbandry' is his ideal, and he firmly believes in its 'rules', even though some of them very inadequately express the facts. The agricultural departments of the colleges necessarily reflect this attitude: farmers and students alike are usually more interested in practice than in science and so more influenced by experience than by experiments: indeed not infrequently they are prepared to ignore or at least heavily discount experimental evidence if it does not fit in with established ideas. Their outlook on Nature is usually vitalistic, and special virtue is always supposed to reside in anything of organic origin as against substances of mineral or synthetic origin.

So a difference in outlook tends to arise between the agricultural research institutes and the agricultural community they are hoping to serve, and the difference is widened by the circumstance that the research institutes, if they are to keep their science at a serious level, have almost always to draw their staff from the science departments of the universities; usually the candidate who is otherwise most suitable has no rural background and no knowledge of agriculture; to acquire this is generally very difficult. It is necessary also to distinguish between the good research man and the good adviser, and to determine the place the adviser should have in the research institute. Broadly speaking, the good research man can see his problem, study it in full detail and find a solution, going on with the work until he has rounded it off properly and written it up for publication. But often it is not immediately useful for practical farming, though, of course, new knowledge is bound to find its place in agricultural science and practice. The good advisory officer can also see his problem and study it in detail; he, too, finds a solution, which may be of more immediate service on the farm than the scientific investigation. But he rarely goes beyond the stage of the interim report, so that his work is never rounded off and much of it never published, to the loss of public funds and the detriment of the juniors who also participated.

In the days when they were small, the research institutes necessarily kept close touch with the farming community and had to do both types of work: the individual members of the staff knew many farmers personally and well. As agricultural science has developed and expanded, it is the advisory officer rather than the research man that has had most to do with practical farming problems. This is in part the explanation of the curious decrying of science by some agricultural writers and the elevation into prominence of some of the mystical hypotheses of plant growth and human and animal nutrition which cannot be tested scientifically. These serious problems in the relation of science to agriculture require fuller study.

SCIENTIFIC CENTENARIES IN 1942

By ENGINEER CAPTAIN EDGAR C. SMITH, O.B.E., R.N.

SCATTERED through the coming year are days which will mark the centenaries of some of the most famous men of all time. In happier circumstances, it may be presumed that already arrangements would be in progress for the commemoration of some of these centenaries on an international scale. But more urgent tasks lie ahead. Yet it may, perhaps, be hoped that such events as the tercentenary of the death of Galileo, the tercentenary of the birth of Newton and the bicentenary of Halley will not be allowed to pass quite unnoticed. It is unnecessary to recall how the researches and discoveries of these great pioneers are closely interwoven, but it may, perhaps, be permitted to recall Rigaud's words regarding the publication of Newton's "Principia". In his essay on that immortal work Rigaud wrote: "Under the circumstances it is hardly possible to form a sufficient estimate of the immense obligation which the world owes in this respect to Halley, without whose great zeal, able management, unwearied perseverance, scientific attainments and disinterested generosity the Principia might never have been published."

When Halley died he had held the office of Astronomer Royal for some twenty years, having succeeded Flamsteed in 1720. His death took place on January 14, 1742, a few months before that of Abraham Sharp, who had furnished Flamsteed with instruments, and of whom Smeaton, in a report in the *Philosophical Transactions* in 1786, said that "I look upon Mr. Sharp as having been the first person that cut accurate and delicate divisions upon astronomical instruments".

Another interesting figure of those times, and one well known in Great Britain, was the Dutch mathematician Wilhelm Jacob 's Gravesande (1688–1742), the first professor of the University of Leyden to teach the Newtonian philosophy, and the author of a work on natural philosophy, Desagulier's translation of which was studied eagerly by James Watt as a boy of fifteen.

The men of science born in 1742 include the famous Swedish chemist Scheele, the German natural philosopher Lichtenberg and the unfortunate French chemist and inventor Nicolas Leblanc. When surgeon to the Duke of Orleans, Leblanc, to gain a prize offered by the Paris Academy of Sciences, set himself the problem of making soda from common salt. After several years he was rewarded with success, and with the aid of the Duke a factory was erected at St. Denis. Then came the French Revolution. The Duke was guillotined, the factory was confiscated and Leblanc forced to reveal his process. After much misery Leblanc, in 1806, died by his own hand. At one time his name was almost forgotten, but to-day his statue stands in the forecourt of the Conservatoire des Arts et Métiers in Paris.

Coming down to 1842 the list lengthens, but it is proposed to refer to only a few of the more important men. In April of that year the British surgeon, Sir Charles Bell, died suddenly at the age of sixty-eight; on September 6 the Belgian chemist Jean Baptiste van Mons passed away at Louvain, having done much to spread a knowledge of the discoveries of Lavoisier and his successors, and on September 21 the British mathematician Sir James Ivory, Copley medallist in 1814, died in Hampstead. The month of February 1842 saw the birth of the French astronomer Camille Flammarion (died, 1925), the month of April the birth of the German astronomer Hermann Carl Vogel (died, 1907). Carl von Linde, the German pioneer of refrigeration, was born in June 1842; the German chemist Albert Ladenburg, in July. Sir William Tilden, Sir James Dewar and Lord Rayleigh were all born in the latter part of 1842, as were also the Norwegian mathematician Marius Sophia Lie, For. Mem. R.S., and the Russian chemist, Nicolai Alexandrovich Menschutkin, one of the outstanding contemporaries of Mendeléeff. Lie died in 1899, Menschutkin in 1907. A memoir of the latter by Tilden appeared in the *Journal of the Chemical Society* in 1911.

OBITUARIES

Prof. Rudolf Schoenheimer

THE death of Rudolf Schoenheimer at the early age of forty-three has removed from our midst a biochemist of outstanding ability. His work, characterized always by originality of conception, has opened up a new, and most fertile, field in biochemistry.

Schoenheimer was born in Berlin in 1898 and he received his M.D. there in 1922. He was associated with the University of Freiburg and became head of its Department of Pathological Chemistry in 1931. He left Germany in 1933 to take up a position as assistant, and later as associate, professor of biochemistry in the College of Physicians and Surgeons, Columbia University. He held this position at the time of his death in September 1941.

Schoenheimer's work, until he went finally to the United States, was concerned primarily with the metabolism of cholesterol. He continued his studies on cholesterol for a few years and in 1934 he commenced his work on the application of stable isotopes to the study of intermediary metabolism. During the following seven years Schoenheimer, usually in co-operation with his colleague D. Rittenberg, developed this new experimental approach to problems of biochemistry.

Much of our knowledge of intermediary metabolism depends on an analysis of the products formed after the administration to an animal of substances which may or may not be normal metabolites. The method has been extended to the use of intact isolated organs (by perfusion techniques) or of surviving tissue slices. Much valuable information has been and is still being obtained by work carried out in this manner. It is recognized, however, that this method of investigation has definite limitations. Administration to the body of relatively large quantities of even normal metabolites may upset the normal balance of events and call forth changes which do not reflect the normal quantitative relationships. Administration of substances, labelled with halogen, phenyl or other groups to facilitate the chemical examination of intermediates in the process of breakdown of the parent substances, involves the use of compounds having different chemical and physical properties from those of normal substrates and metabolites. Such substances, foreign to the body, may be treated, in certain respects, differently from normal substances. Yet the elucidation of the intermediate steps in the course of breakdown of normal substrates in the body or in the living cell represents one of the most important and formidable problems in biochemistry.

The introduction into a metabolite of isotopes of one or more of its elements brings about little or no change in its physical or chemical properties, and hence it is not to be expected that the animal will be able to differentiate between a normal metabolite and one containing isotopes of its elements. Experimental evidence exists which supports this conclusion. Since it is now possible to distinguish isotopes and to estimate them in relatively small quantities and in high dilutions, it is obvious that the use of molecules containing isotopes places a new and most powerful weapon in the hands of the biochemist.

The first to realize the importance of isotopes for biological investigations was von Hevesy, who studied phosphorus metabolism, using radioactive phosphorus. Radioactive isotopes of hydrogen and nitrogen, however, the migrations of which in the body form so important an aspect of intermediary metabolism, were not known, at the time of Schoenheimer's work, with a half-life long enough to permit their use in metabolism experiments. It was necessary to use stable isotopes concentrated from the natural mixtures. Urey, by devising methods of isotope fractionation, made it possible to use such isotopes in metabolism work.

The first series of experiments of Schoenheimer and his colleagues (*J. Biol. Chem.*, 1935–38) was concerned with the use of deuterium. They employed two methods of attack. They administered heavy water to animals over a certain period and then estimated the stable deuterium in the different organic constituents of the body. This gave information on the nature of the substances utilizing hydrogen of the body fluids themselves. They synthesized and administered organic compounds containing deuterium and followed up the fate of the isotope. This gave information on the mode of breakdown of the labelled organic compound.

They were able to show, on feeding fats containing deuterium, that the major part (even if administered in relatively small amounts) is deposited in fat depots prior to utilization. They showed that desaturation of fats, as, for example, the transformation of stearic acid into oleic acid, and that the conversion of stearic acid into palmitic acid, are processes definitely occurring in the animal body. They showed that reversible saturation and desaturation of fats are normal metabolic changes. Schoenheimer and his colleagues further demonstrated, by feeding experiments with deuterobutyric and caproic acids, that these short-chain fatty acids are completely burned in the body and not used for fat formation. They followed fatty acid development in the embryo and in the adult animal and investigated sterol metabolism and synthesis. In all these investigations they were faced with serious difficulties, having to devise methods of synthesis of isotope-containing compounds and to cope with the problem of the stability of the carbon-bound hydrogen *in vivo*.

Schoenheimer and his colleagues turned their attention to the study of protein metabolism using ^{15}N as the isotopic label (*J. Biol. Chem.*, 1939–41). This isotope was estimated by means of the mass-spectrograph. They showed that isotopes ^{14}N and ^{15}N are treated by the body indiscriminately in anabolic and catabolic processes. They found that administered glycine (marked with ^{15}N) may be used partly for hippuric acid synthesis, that animals fed with isotopic ammonium citrate form proteins, the constituent amino acids of which, with the exception of lysine, contain ^{15}N. This made it evident that amino acids can be built up in the body from dietary ammonia. The fate of amino acids such as tyrosine containing ^{15}N, after ingestion by an animal, was investigated and it was shown that part of the ^{15}N is transferred to various other amino acids in the proteins of the animal. The experiments indicated that in a normal full-grown and healthy animal, kept on a normal diet, the nitrogen of the dietary amino acid may only partly be excreted in the urine, the rest being retained in the protein of the animal with a corresponding excretion of tissue nitrogen. The exceptional property of lysine, among the amino acids, in resisting the introduction into its molecule of ^{15}N, after the ingestion by an animal of isotopic nitrogen, was demonstrated. Apparently lysine is not involved in the reversible shift of amino groups, which seems to be a prominent feature of nitrogen metabolism of the body.

It is clear that metabolism work involving the use of isotopes has just begun, and the significant results already obtained justify a great extension of the work. It is indeed a tragedy, and a most serious loss to biological science, that Schoenheimer should have been cut off at so early an age from those pioneer investigations the future of which is so full of promise.

J. H. QUASTEL.

Dr. W. Steiner

DR. WERNER STEINER, born 1896 at Cologne, died after a brief illness on September 10 at Durham. From 1926 onwards he was Prof. M. Bodenstein's assistant in the Institute of Physical Chemistry at Berlin and in charge there of the teaching and research work in spectroscopy. He published some thirty valuable papers on this and related subjects, several of them in English journals. After leaving Germany in 1933 he worked for a while on similar lines at Cambridge in the laboratories of the late Prof. T. M. Lowry. In 1936 he accepted the position of a science master at the Gordonstoun School in Morayshire, and in January 1941 at the Durham School. Here, as well as in his University career, he gave of his best. Besides science his main interest was divinity, and his last contribution was to a theological journal.

F. A. PANETH.

WE regret to announce the following deaths:

Mr. F. A. Leete, C.I.E., lately chief conservator of forests, Burma, on December 11.

Prof. J. Wilson, formerly professor of agriculture in the Royal College of Science, Dublin, on December 9, aged seventy-nine.

NEWS and VIEWS

Great Britain and the United States

THE Association of Scientific Workers has, through its Social Relations Committee, recently sent the following message to American men of science: "We British scientists, engineers and technicians organised in the Association of Scientific Workers send our greetings to our colleagues in the United States of America. . . . With the combined might and resources of the U.S.A., the U.S.S.R., China and the British Commonwealth of Nations, ultimate victory is certain. We are nevertheless faced by a powerful and desperate combination of powers. They too have large resources and the advantage of having planned for war many years before actual fighting started. Their scientists have been concerned with the specific problems of warfare and supply for many years longer than we have. We must make up this leeway. But we can do more than that. We, the scientists in the Allied countries, can by pooling our ideas, technical skill and cognate information, play in concert a most vital part in the common effort. . . . We are happy to recall the very close bonds which have united men of science of our two countries in the past. Many of us have personal friends among you. We have worked in your great laboratories; you have worked in ours. This interchange will prove to be most valuable in the present situation. We have as well the terrific advantage of a common language, and, to a large extent, of a common cultural heritage. But we still have a lot to learn from each other and from our Soviet colleagues. By helping each other without stint, we shall help ourselves and we shall be laying the foundations of a truly international scientific commonwealth. American, Soviet and British scientists have the responsibility of preserving the scientific heritage of the whole world against the barbarism and obscurantism of Fascist 'ideology'. We shall do it, and we shall enrich and strengthen it by so doing. Our most sincere and best wishes to you."

The Empire Bond

YET another sign, if such be needed, of the intangible bond which links together the several members of the British Commonwealth of Nations is provided by the letter printed on p. 21 of this issue, from the honorary secretary of the Australian National Research Council. In this letter, Dr. H. R. Carne offers hospitality in Australian laboratories to scientific workers in Great Britain who are unable to make any direct contribution to the war effort. Not only scientific workers in Great Britain, but also the many students from other parts of the Empire who would normally be proceeding to postgraduate courses or research work in this country but are prevented by present circumstances, are offered an invitation to utilize the universities and research institutes of Australia, to carry on their work. While it is unlikely that many in Great Britain will be able —or will indeed wish—to leave the country at the present time, scientific workers everywhere will appreciate the friendly spirit in which the invitation has been given, and will wish to thank their Australian colleagues for the very practical form which their concern about the influence of war-time conditions on research has taken. Although the outbreak of war in the Pacific may make it necessary for Australian institutions to modify their offer (Dr. Carne's letter was dated September 19), the fact that it was made by a country already deeply involved in the War is worthy of record.

Malayan Wild-Life

THE war in Malaya is no doubt interfering with the very interesting wild-life of that region, and the observations that have so long centred upon it. Robinson and Chasen's work on the birds of Malaya describes such interesting items as the breeding habits of the edible-nest swiftlets, the gorgeous sunbirds and the spider-hunters. Malaya has some seven hundred birds including about forty game birds and pigeons. An earlier official publication on the birds of Singapore gives a list of more than a hundred species, including eleven of the sixteen Malayan kingfishers and many interesting doves, hornbills, the vividly coloured little red and orange flower-peckers that haunt the tree-tops, the rollers, the bee-eaters and several swifts. Many species well known in Britain are winter visitors or migrants from northern Asia, including snipe, golden plover, redshank, turnstones, greenshank, and grey plover. The roseate and gull-billed terns are regular birds of Singapore island, the Kentish plover nests on the sandy shores and herons and white egrets fish the marshes. The fishing owl is a very common bird. The "Handbook to British Malaya" states that the fauna of British Malaya is excelled in number of species only in parts of South America. The one-horned Javan rhinoceros is almost extinct, and the common rhinoceros, like the Malayan elephant, has been much persecuted for ivory. The ancient Malayan tapir survives, but the Malayan bison or seladand is almost extinct in certain districts. There are several deer, and the curious serow or goat antelope is in the remoter country. The Malaya tiger is smaller than the Indian, while monkeys and apes include the curious nocturnal slow loris and also orangs, which have often been collected for European zoos. Malaya is the metropolis of the squirrels and there are more than sixty bats, including the great flying fox or keluan with a wing span of nearly five feet, which haunts the coastal mangroves.

As well as the big game hunting, the snipe-shooting and pigeon-shooting are among the best in the world, but collectors have also been attracted to Malaya for fauna and flora. Corbett and Pendlebury's 1934 work on the butterflies of Malaya records more than eight hundred species. There are probably a quarter of a million insects including more than a thousand butterflies in this region, with many of the swallowtail family. There are the famous birdwing butterflies which often feed with their forewings fluttering and their hindwings kept fairly still. One of the most striking butterflies in the world is Rajah Brook's birdwing, *Papila brookiana*, with a wing span of 6¾ in., which was discovered by Dr. R. A. Wallace in Borneo. The sex ratio is such that the female is about one to every thousand males. The long-tailed blue butterfly of the English list also occurs here, and there are many skippers. There is also the giant atlas moth. Reptiles are not quite so evident as in India and Australia, but crocodiles are numerous, and Russell's viper and other deadly Indian snakes are found here too ; also the largest living snake, the king cobra or hamadryad, with a recorded length of 18 ft. 6 in. There are many lizards, turtles and tortoises, including the flying lizard. There are some three hundred fishes in the rivers, including catfish and carp.

The flora of Malaya has been written up by H. N. Ridley, while from a horticultural point of view, the Western world has sent many collectors for its orchids. There are twenty-eight Vitis plants, sixteen Vacciniums and some seven hundred orchids and wild forms of many Western garden favourites like *Canna orientalis.* There are twenty-one Dracænes, thirteen Carex, five Scirpus, three Lemna and the tiny Waffia's microscopic flowers in the ditches and wells. Some plants familiar to British botanists include the common reed *Phragmites communis* on river banks, the chickweed, *Stellaria media,* as a weed of cultivation and the dandelion *Taraxacum Dens-Leonis,* an "escape' on the Penang Hill. The Malayan flora totals some nine thousand species, and of more than three hundred trees in which the tall Dipterocarpaceæ predominate, some half are peculiar to the Peninsula. Lianas, rhododendrons, epiphytes and small palms are characteristic.

Television in Colour and Stereoscopic Relief

HITHERTO, television has been confined to flat pictures. In a press demonstration on December 18, Mr. J. L. Baird demonstrated stereoscopic relief in combination with television in colour. Mr. Baird states that his first experiment in this direction was applied to his 600-line two-colour apparatus. The red image was made to 'view' the scene from a slightly different angle from the blue, so that the red and blue images constituted a stereoscopic pair, the receiving screen being viewed through glasses fitted with red and blue filters as in the anaglyph process. This, while simple, had the disadvantage that it was necessary to wear glasses and that, as the colour phenomenon was used to effect the change over from the right to the left eye, neither the colours nor the stereoscopy could ever be properly rendered. So far the object in mind had been to produce a system capable of being transmitted through the existing channels available to the B.B.C., but in an endeavour to produce as perfect a result as possible, it was decided to produce an entirely experimental apparatus regardless of existing practical limitations.

In the apparatus now demonstrated by Mr. Baird, the frame frequency has been increased from 50/sec. to 150/sec., the scanning altered to a field of 100 lines interlaced five times to give a 500-line picture, successive 100-line frames being coloured green, red and blue. At the transmitter a cathode ray tube is used in conjunction with photo-electric cells, the moving light spot being projected upon the scene transmitted. In front of the projecting lens a mirror device consisting of four mirrors at right angles splits the emerging light beam into two paths separated by a space equal to the separation of the human eye. By means of a revolving shutter the scene is scanned by each beam alternately, so that images corresponding to the right and left eye are transmitted in rapid sequence. Before passing through the shutter disk the light passes through a rotating disk with blue, red and green filters. Thus superimposed red, blue and green pictures blending to give a picture with full natural colours are transmitted for left and right eye alternately. At the receiver the coloured stereoscopic pairs of images are reproduced in sequence and projected upon a field lens, alternate halves of the projecting lens being exposed by means of a rotating shutter, the image of the shutter being projected upon the eye of the viewer so that his left and right eyes are presented alternately with the left and right images, the combined effect being a stereoscopic image in full natural colours.

Poverty and Malnutrition in South Africa

EVIDENCE given to the Industrial and Agricultural Requirements Commission by Dr. T. W. B. Osborn on March 17, 1941, has now been published under the title "Remedies for Poverty and Malnutrition in South Africa". (Pp. iii+22. Johannesburg : Central News Agency, Ltd., 1941. 2*s*. 6*d*.). Dr. Osborn, pointing out that the mines managements of the Rand have already convinced themselves that it pays to put their native labour force on a well-balanced ration, emphasizes the significance of the prevention of malnutrition in regard to infantile mortality and general physique among the Bantu. The potential production of foodstuffs in South Africa is considered more than sufficient to give each member of the community an ample balanced diet. Distribution is the major problem—getting the right food to the people, by increasing their purchasing power, subsidizing consumption, or free distribution. He criticizes milling practice in the cereal industry and asserts that it is essential that the germ of the wheat should go back into refined flour and mealie meal. The conversion of more skim milk into food for human consumption, development of the margarine industry on the grounds of price, in spite of the butter surplus, encouragement of soya bean growing, of the consumption of meat, fish and peanuts by the poorer sections of the community, and of the use of vegetables and fruit rich in vitamin C, such as guavas and red peppers, are also advocated.

The consumption of these foods so as to eliminate malnutrition should be encouraged within the present economic framework by a system of subsidies, preferably a combination of free distribution, subsidy to the consumer and subsidy to commerce. Dr. Osborn cites for example a scheme to encourage the use of mealie meal containing 5 per cent of soya bean meal, and then discusses the long-term solution of the problem of removing poverty in the midst of plenty. This means raising the general standard of living and making the economic struggle for existence less intense and ruthless. The final aims are to induce the maximum of economic efficiency, economic equity and personal freedom. Raising wages and reducing costs are not general remedies. They must be supported by measures to stimulate investment and consumption, and Dr. Osborn stresses the value of more generous State provision for sickness, old age and child welfare, the endowment of research, public works, consumer subsidies and the encouragement of drama and the arts. Means to check inflation are essential as well as the control of land values, the share market and overseas influences. Economic self-sufficiency he considers is not necessarily retrograde, but he emphasizes the necessity of unorthodox methods and also of safeguards against bureaucracy in the economic planning required.

The Forests of India

IT would perhaps be difficult to find stronger evidence of the changes which have taken place in the management of the forests of India and the almost complete manner in which the Secretary of State for India, and the Central Government of India itself, are dissociating themselves from their administration, than is provided by the Inspector-General of Forest's Quinquennial Review ending March 31, 1939. (Ann. Return of Statistics relating to Forest Administration in British India for 1938–39 and Quinquennial Review ending March 31, 1939. Govt. of India Press, Calcutta, 1941.) For well over half a century the forests of India, their protection and improvement (and incidentally the increasing revenue they yielded), had formed a personal pre-occupation of successive Secretaries of State for India and (with that spur) of successive Governors-General and Viceroys. With increasing efficiency in management it became no longer possible for an inspector-general to portray in an annual report, kept within official requirements of space, the work being carried out throughout India and Burma. The latter was therefore reduced to tabular statements of statistics only, whilst a quinquennial report gave an eye-picture of the progress in management and the position of the forest estate.

It can now be realized that these reports have the very highest value in the light of the new position brought about by the Government of India Act, 1935, under which the forests are transferred to the individual provinces. The India Forest Service at present numbers 219 officers, of whom 163 were recruited at home direct to the Service. Gradually, with the retirement of these officers, the forests and their management will become purely the affair of the various provincial Governments. Even the senior administrative appointments, conservators and chief conservators in provinces, will no longer, it is said, be made by the Central Government. The Government of India still maintains an Inspector-General of Forests, shorn of all power, who is at the same time president of the Forest Research Institute and College at Dehra Dun. At the College the officers for the new 'Superior Forest Services' of the individual provinces are to be trained. The Inspector-General is permitted to visit, on invitation, the various provinces, but his reports on such visits are purely advisory. In fact, as the Quinquennial Report for 1934–35 to 1938–39 indicates, the chief position in forestry administration of the Inspector-General at the present time is his occupancy of the presidentship of the Research Institute. Out of 24 pages in this report less than six are devoted to describing work of purely forest management, and the remainder to forestry research work. Yet this latter is dealt with very fully in the annual reports of the Research Institute.

The annual revenue from the great forest estate of India and Burma for the year 1936–37 (before the separation of the latter) amounted to Rs.4,38,07,019, or well over three million pounds sterling. In addition nearly half a million pounds sterling of forest produce is given away free or at reduced rates. Many senior men with long experience in the administration of this great forest estate, the correct management and maintenance of which is vital to India as a whole, view with concern and distrust the devolution of their powers and responsibility by the Secretary of State and Governor-General.

An Index to Horticultural Research

THE availability of research results of a purely horticultural character has been greatly increased by the publication of *Horticultural Abstracts* by the Imperial Bureau of Horticulture and Plantation Crops, East Malling, Kent. Mr. D. Akenhead, deputy director of the Bureau, has now compiled an index to the first ten volumes, covering the period 1931–40 (Sept. 1941, 160 pp., 25*s*.). The volume contains a subject index and an alphabetical list of authors; it is world-wide in scope, and demonstrates the prosecution of an enormous volume of horticultural research during the decade it reviews. Greatest use of the index demands its relation to the journal which it serves, but the research worker can see from the present volume whether any work in his particular line has been reported. Detail is quite adequate for modern needs, for a reference can be found to apple sauce as well as to *Rhizopus arrhizus* rot of that crop, and to the utilization of waste potatoes, in addition to rubidium absorption in potato disks. The subject index is compiled with the different crop plants as the chief points of interest. The volume certainly achieves its expressed object of making information as available to the English-speaking horticultural worker as possible.

Health of Palestine

ACCORDING to the report for 1939 recently published by the Department of Health in Palestine, the country was so much disturbed by political strife in that year as to prevent development of health work. The health of the people, however, was remarkably good, and there were no important epidemics. The recorded incidence of infectious diseases was the lowest for many years, and the death-rate from them half that of 1931. The total population numbered 1,501,698, of which 60 per cent were Moslems, 30 per cent Jews and 10 per cent Christians and others. The birth-rate was twice as high among Moslems (46·4 per cent) as among the Jews (23·0 per cent). Both rates were falling, but that of the Jews more rapidly than that of the Moslems. The death-rate of the Moslems was much more than double that of the Jews. Infantile mortality was 121·5 per 1,000 live births among the Moslems and 54 among the Jews; for Christians the rate was 101. These rates were the lowest ever recorded and showed a sharp decline from previous years. Of the various diseases diarrhœa caused 1,336 deaths and pneumonia 1,258, then in order of frequency came heart disease 617, cancer 364, cerebral hæmorrhage 311, and nephritis 276. 3,394 cases of malaria were reported with 15 deaths, 1,235 cases of typhoid with 134 deaths, and 175 cases of paratyphoid with 2 deaths. There has been no increase in tuberculosis in the last ten years. Ophthalmias are a formidable problem.

Piezo-Electro Crystal Filters

A BRIEF outline of the history of the crystal filter has been published by J. E. Benson (*A.W.A. Tech. Rev.*, 5, 191; 1941). The earliest application of piezo-electric crystals to frequency-selective circuits appears to have been made in 1920 by W. G. Cady, whose patent describes the behaviour of piezoelectric elements near resonance and their consequent use in the selection and measurement of high frequencies. L. Ezpenschied (Jan. 3, 1927) described the quartz-crystal band-pass filter having recurrent sections. This was followed by W. A. Marrison's patent (June 7, 1927) for a balanced crystal-gate filter designed for sharp response at a single frequency. In the same year, C. W. Hansell developed a similar bridge-balanced system, in which the parallel capacity of the crystal was balanced out of an equal capacity supplied from the input circuit in opposite phase to the crystal. Single-frequency rejection filters of the *T*-section type having a piezo-electric element in the shunt arm were described at about the same time by I. F. Byrnes. J. Robinson's stenode radiostat using a balanced crystal-filter circuit appeared in 1929.

Recent Earthquakes

ACCORDING to a radio message from Tokyo, the largest earthquake since 1930 shook southern Formosa on December 17. The epicentre is likely to have been near the town of Kagi around which most of the damage was done. Seventy-seven people were seriously injured and eighty-seven slightly hurt when 612 houses were destroyed and 918 badly damaged. Railway and telephone communications were temporarily severed. On the same day a violent earthquake occurred in the Mughla district of south-western Anatolia in Turkey. Damage was done to about eight hundred houses and a hospital, but only a few persons were injured. On December 20 an earthquake of moderate intensity shook Quetta. The shock lasted, according to human perception, for about ten seconds and was accompanied by a low rumbling sound. No damage has been reported, probably due to the new town having been built according to earthquake-proof design.

Institute of Physics Planning Committee

THE Board of the Institute of Physics has appointed a planning committee with the following terms of reference: "To watch and to advise the Board on matters affecting Physics and Physicists, including their education and training, and on post-war planning." The constitution of the Committee, which has power to co-opt, is as follows: Sir Lawrence Bragg, Prof. J. A. Crowther, Mr. E. R. Davies, Dr. H. Lowery, Major C. E. S. Phillips, Dr. C. Sykes, Dr. F. C. Toy. At the request of the Board the Committee will proceed at once to consider certain matters concerning the education and training of physicists. Close contact will be maintained with the participating societies of the Institute, namely the British Institute of Radiology, the Faraday Society, the Physical Society, and the Royal Meteorological Society, as well as with other bodies concerned with the application of physics to industry.

Announcements

PROF. HENRY NORRIS RUSSELL, research professor of astronomy at the University of Princeton, has been elected to an honorary fellowship at King's College, Cambridge. Prof. Russell, who is the doyen of American astronomers, graduated as Ph.D. at Princeton, after which he entered King's College, Cambridge, as an advanced student in 1902, and was in residence at Cambridge for three years. During that time he carried out research in collaboration with Mr. A. R. Hinks, now secretary of the Royal Geographical Society, upon parallax, and the methods they developed have become standard. This no doubt was a first step on the way to some of Prof. Russell's most notable work.

THE Harrison Memorial Prize, which is awarded by a selection committee consisting of the presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, has been awarded for 1941 to Dr. Henry Norman Rydon. This prize is given to a chemist of either sex who is a natural-born British subject, not more than thirty years of age, who, in the opinion of the selection committee, shall during the previous five years have conducted the most meritorious and promising original investigations in chemistry. The Prize is to be regarded as an exceptional distinction to commemorate an exceptional man.

THE Town and Country Planning Association has arranged a series of fortnightly lunch-time meetings at 1.20 on "Post-War Reconstruction", beginning on January 8, at the Dome Lounge, Messrs. Dickins and Jones, 224 Regent Street, London, W.1. Admission is by ticket obtainable from the Association. The first meeting will be addressed by Mr. George Hicks, parliamentary secretary to the Ministry of Works and Buildings, who will discuss the part the Ministry can take in reconstruction.

REFERRING to the obituary notice of Mr. R. T. Baker in NATURE of December 13, p. 718, Prof. John Read writes that Mr. Baker died at Cheltenham, New South Wales, on July 14, aged eighty-six years.

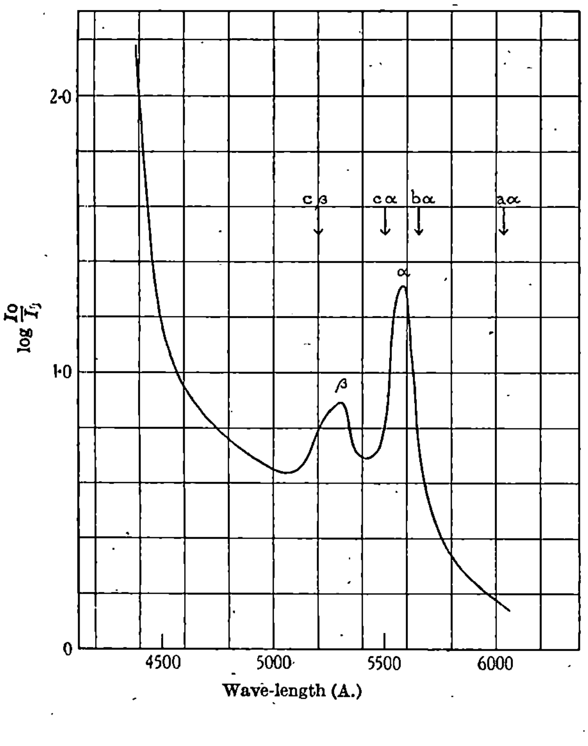
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Soluble Cytochrome Component from Yeast

HITHERTO cytochrome *c* is the only component of cytochrome which has been obtained in solution, the others being attached to the insoluble parts of the cell structure.

During the purification and concentration of the lactic dehydrogenase of yeast, as described in a future communication, we have obtained a new cytochrome which is extremely soluble in water. The positions of the bands of its absorption spectrum do not correspond with those of any cytochrome component known hitherto. The new component appears to be present in yeast in amounts too small for its detection by direct spectroscopic observation of the yeast cells ; but its spectrum becomes visible on removal of other coloured substances and concentration. We have obtained it in strong solution, red in colour, and free from other cytochromes. Its absorption spectrum in the reduced state, as determined in a Hilger-Nutting spectrophotometer, is shown in the accompanying graph, in which the positions of the bands of cytochromes *a*, *b* and *c*, as ordinarily seen in yeast, are also indicated. Its α band is situated at 5570 A., between the α bands of cytochrome *c* (5500 A.) and cytochrome *b* (5650 A.) ; the β band, which is unsymmetrical, has its peak at 5300 A. If a trace of cytochrome *c* is added, a distinct space can be seen between the α bands of the two cytochromes. In liquid-air the bands become much sharper ; the α band then appears double. The new component, unlike cytochrome *c*, is somewhat autoxidizable, and its bands disappear on shaking with air.



The spectrum is clearly that of a hæmochromogen. This hæmochromogen does not combine with carbon monoxide in neutral solution, and in this respect it resembles cytochromes *a*, *b* and *c*. On denaturation with dilute sodium hydroxide and addition of pyridine and hyposulphite, it is converted into pyridine hæmochromogen, with absorption bands identical with those of pyridine protohæmochromogen. The pigment, therefore, has a protohæmatin prosthetic group, like cytochrome *b* and unlike cytochromes *a* and *c*. By converting the pigment into its pyridine hæmochromogen and comparison with standard hæmochromogen solutions by the spectroscopic method described by Keilin[1], its concentration may be estimated with great accuracy. This makes it possible to calculate the absorption coefficient, which for the α band is found to be $\beta_{5570} = 0{\cdot}4 \times 10^8$ cm.^{2}/gm. atom Fe. The new cytochrome resembles cytochrome *b* not only in the nature of its prosthetic group, but also in being autoxidizable to some extent in neutral solutions. In order to avoid confusion with other hæmatin compounds, we suggest that it should be called cytochrome b_2.

Owing to the impossibility of obtaining Delft yeast, we have not been able to study the catalytic properties of cytochrome b_2 in detail. We have, however, found that it is not capable of replacing the substance[2] linking the succinic system with cytochrome *c* which is destroyed at *p*H 5, and which it has been suggested[3] might be cytochrome *b* or a hitherto unrecognized component. The identity of cytochrome b_2 with the yeast lactic dehydrogenase is discussed in a future communication.

S. J. BACH.
MALCOLM DIXON.
D. KEILIN.

Biochemical Laboratory
and Molteno Institute,
Cambridge.

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[1] Keilin, D., *Proc. Roy. Soc.*, B, **113**, 393 (1933) ; NATURE, **148**, 493 (1941).

[2] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **129**, 277 (1940).

[3] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **127**, 167 (1939).

R279

X-Ray Study of the Elastic Constants of Metals

IN a recent letter[1] we showed that the diffuse X-ray reflections from single crystals of alkali metals are related to the elastic constants in just the way predicted by the Waller theory[2], as interpreted and applied by Jahn[3]. We are now able to give data for sodium which will illustrate this more conclusively.

The figures represent the intensity of diffuse reflecting power on the surface of a sphere surrounding the reciprocal lattice point (*hkl*), in the direction [*pqr*], as calculated from Jahn's formula. The observed intensities are derived from visual estimation on a series of Laue photographs taken at degree intervals, in various crystal orientations, the range of each set of photographs being sufficient to cover the entire observable reflecting region for each plane. Allowance has been made for the usual factors which affect the normal reflexions (structure factor, atomic scattering factor, factors involving the crystal and film positions relative to the incident beam), and which also, of course, affect the diffuse reflexions.

	Calculated intensities:				Observed intensities:			
± [*pqr*] (*hkl*)	(002)	(110)	(112)	(222)	(002)	(110)	(112)	(222)
[100]	24	22	24	23	—	—	—	—
[010]	24	22	24	23	—	—	—	—
[001]	19	24	21	23	—	—	—	—
[110]	24	11	20	16	—	—	—	—
$[1\bar{1}0]$	24	165	71	141	—	V.S.	M.	S.
[101]	88	56	30	16	M.S.	M.	W.	—
$[10\bar{1}]$	88	56	133	141	M.S.	M.	S.	S.
[011]	88	56	30	16	M.S.	M.	W.	—
$[01\bar{1}]$	88	56	133	141	M.S.	M.	S.	S.

Sodium single crystals are very soft and elastically anisotropic; they are body-centred cubic in structure. Lead single crystals are also soft and are anisotropic in the same sense ($c_{11}-c_{12} < 2c_{44}$), although the shear constant c_{44} is much smaller relative to the compressibility ($c_{11} + 2c_{12}$); but they are face-centred cubic in structure. Diffuse reflexion photographs (which are particularly good for large angles of incidence, on account of the slow decrease of the atomic scattering factor) show that the reflecting regions in reciprocal space are similar to those found for sodium, although the intensity 'spikes' are less pronounced. At low temperatures the diffuse reflexions almost disappear, but the Laue spots become much more numerous and the background clearer.

Tungsten crystallizes, like sodium, with a body-centred cubic structure, but it is elastically isotropic ($c_{11}-c_{12} = 2c_{44}$) and the elastic constants are large.

	c_{11}	c_{12}	c_{44}	$c_{11}-c_{12}$	$c_{11}+2c_{12}$	($\times 10^{11}$dynes/cm.^{2})
Na	0·52	0·40	0·41	0·12	1·32	(4)
Pb	4·77	4·03	1·44	0·74	12·83	(5)
W	51·3	20·6	15·3	30·7	92·5	(6)
	50·1	19·8	15·1	30·3	89·7	(7)

For tungsten, the Jahn formula predicts small, elliptical diffuse spots which should disappear at a very small angular distance from the Bragg position. This is exactly what we find. The diffuse spots are smaller than the Laue spots, and disappear at $\theta_B \pm 2°$; there are none of the detailed, persistent groups of spots and streaks (some of which extend right across the Brillouin zone boundaries) that are found for both sodium and lead. A rough calculation, which is in good qualitative agreement with our observation, indicates that the tungsten diffuse reflexion should be about $\frac{1}{30}$, and that of lead about $\frac{1}{2}$, as intense as the diffuse reflexion from sodium, for the first observed order from (110) planes.

The thermal theory predicts that the relation of diffuse to normal (Bragg) reflecting power for any set of planes should be governed by the actual values of the elastic constants and not primarily by the crystal structure. In our opinion, this is proved by the above experiments on single crystals of metals.

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H. Smith.

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Albemarle Street,
London, W.1.

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[1] Lonsdale and Smith, Nature, **148**, 628 (1941).

[2] Waller, "Theoretische Studien zur Interferenz- und Dispersionstheorie der Röntgenstrahlen" (Uppsala: Universitets Årsskrift, 1925).

[3] Jahn, Nature, **147**, 511 (1941); *Proc. Roy. Soc.*, A (in the press).

[4] Quimby and Siegel, *Phys. Rev.*, **54**, 299 (1938); data extrapolated to room temperature.

[5] Goens, *Phys. Z.*, **37**, 321 (1936); data corrected for an arithmetical error.

[6] Bridgman, *Proc. Amer. Acad.*, **60**, 305 (1925).

[7] Wright, *Proc. Roy. Soc.*, A, **126**, 613 (1930).

A Reversible Discharge Tube

R. W. Wood[1] has described an interesting discharge tube which could be made to exhibit "either the spectrum of atomic hydrogen or molecular oxygen at will" on excitation by a high-frequency discharge. In the course of investigations on the spectra of gases excited by high-frequency discharge, we have prepared a discharge tube which has an analogous behaviour and can be made to show either the air spectrum or hydrogen spectrum as desired. The fundamental difference between the two tubes, however, is that under the discharge hydrogen is suppressed by oxygen in Wood's tube, whereas here, hydrogen suppresses air.

The discharge tube, which has a quartz window and aluminium electrodes, was sealed off the evacuation apparatus after being repeatedly washed by hydrogen. The spectrogram taken soon afterwards showed only the spectra of hydrogen, in particular a very intense development of the well-known continuous spectrum of hydrogen. The tube was excited by high-frequency discharge. On standing for a few days the tube, on similar excitation, showed only nitrogen bands in the visible, clearly due to traces of residual air, and there was no trace of hydrogen. On continued excitation, however, hydrogen gradually appeared, nitrogen got weaker and in a couple of hours the tube showed nothing but hydrogen, nitrogen being suppressed under the discharge. The continuous spectrum of hydrogen was found to be considerably weakened in intensity while the atomic spectrum was very prominent, due, no doubt, to the absorption of hydrogen by the walls of the tube resulting in a gradual 'clean up'.

On cutting off the discharge and allowing the tube to rest for some period, the same series of phenomena can be repeated. Most of the hydrogen appears to be confined to the electrodes, for it has been possible so to excite the tube with external electrodes that, by omitting the internal electrodes from the path of discharge, the tube shows only the spectrum of air for any length of time.

R. K. Asundi.
Nand Lal Singh.
Jag Deo Singh.

Benares Hindu University,
Oct. 25.

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[1] *Phys. Rev.*, **35**, 658 (1930).

Psycho-Physical Significance of the Dissipation Coefficient of Soft Materials

In an earlier communication[1] we raised the question of the significance of the dissipation coefficient (k) of soft materials, which we measure by compressing cylinders under loads compensated to ensure constant shear stress (S). For materials the firmness (ψ) of which is independent of stress, k is defined by an equation of the Nutting type[2]

$$\psi = S\sigma^{-1}t^k,$$

where σ is shear strain and t is time.

Broome and Bilmes have shown[3] that k is also given by the ratio of mean to differential viscosity ($S/\frac{\sigma}{t} \div S/\frac{\partial\sigma}{\partial t}$) and, for relaxation at constant strain, differentiation shows that the Maxwell relaxation time will vary as a power ($1/k$) of the stress.

In order to establish the psycho-physical significance of k, we have given pairs of cylinders to groups of ten subjects who, squeezing the cylinders under controlled conditions, were asked to decide which was the firmer of each pair, the squeezing being timed to take ½, 1, 2 and 4 sec. respectively. When a standard bitumen (viscosity $= \eta$; $k = 1$) is compared with a series of rubbers ($k = 0$) of varying shear moduli (n), a unique curve is obtained when p (percentage "bitumen softer" answers) is plotted against nt. The time required to give an equality point corresponding to the case where η is numerically equal to n, is not equal to the time-unit from which η is calculated (1 sec.) but to a fraction ($\alpha = 1/3$) of this value.[4]

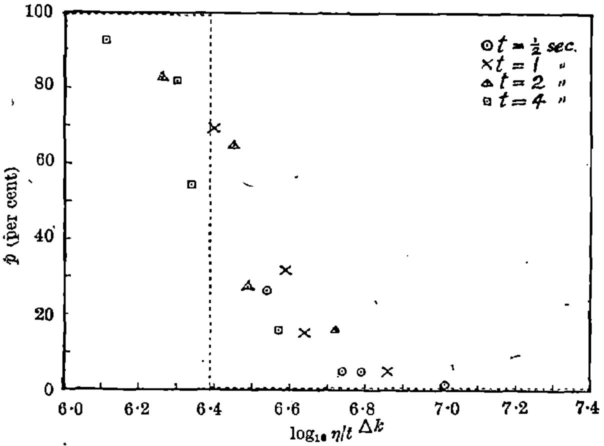

Fig. 1.

The dotted lines represent the curves obtained from the data from the compression machine.

In order to study further the relationship between α and the difference between the k-values of the materials (Δk), we have done two further experiments (I and II) with ten subjects, giving three sessions per experiment and 32 judgments per session, that is, 960 judgments per experiment. A series of fluid bitumens was compared with (I) an unvulcanized rubber ($k = 0{\cdot}50$; $\psi = 2{\cdot}5 \times 10^6$) (we are indebted to Dr. L. R. G. Treloar, of the British Rubber Producers' Research Association, for this material); and (II), a synthetic rubber-clay-Vaseline mixture ($k = 0{\cdot}22$; $\psi = 4{\cdot}0 \times 10^6$). The Δ k-values were, therefore, 0·50 and 0·78.

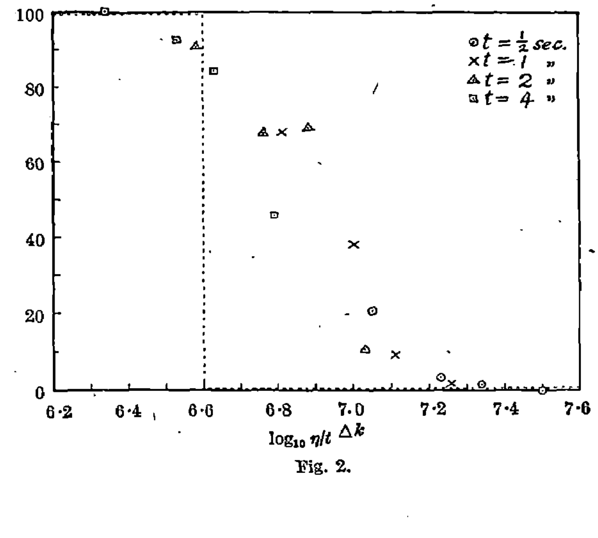

Fig. 2.

The accompanying graphs show that unique curves are obtained by plotting p against log ($\eta/t^{\Delta k}$). Thus, from subjective comparisons of the firmness of a material with that of a true fluid, we can derive the dissipation coefficient, although no conscious judgment of this property is given by the subjects. This is a strong point in favour of the use of the Nutting type of equation, especially where subjective judgments are of industrial importance.

In experiment I, α is 0·98 and in II, 0·45, subject to a fair margin of error. The relationship between α and k should be further investigated.

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F. M. V. COPPEN.

National Institute for Research
in Dairying,
University of Reading.

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[1] Scott Blair, G. W., and Coppen, F. M. V., NATURE, **146**, 840 (1940).

[2] Nutting, P. G., *Proc. Amer. Soc. Test. Mat.*, **21**, 1162 (1921); *J. Franklin Inst.*, **191**, 679 (1921).

[3] Broome, D. C., and Bilmes, L., *J. Soc. Chem. Ind.*, **60**, 184 (1941).

[4] Scott Blair, G. W., and Coppen, F. M. V. (in process of publication in the United States).

Hospitality in Australia for Scientific Workers

AMONG the ranks of scientific workers in Great Britain there must be a considerable number who are unable to make any direct contribution towards the nation's war effort and whose researches have been seriously interfered with or stopped by various circumstances arising from the War.

Australian men of science have widely expressed their wish to extend the hospitality of their laboratories to such scientific colleagues in Great Britain, so that they may continue with their work.

The Australian National Research Council has made inquiries to ascertain what facilities the universities and research institutes of Australia can offer, not only to colleagues in Great Britain, but also to those men of science in other parts of the Empire who normally would proceed to the United Kingdom for study leave or postgraduate courses but are now debarred from doing so.

The response to this inquiry indicates that scientific laboratories throughout Australia are anxious to offer such hospitality, and that facilities are available for workers in almost all branches of science.

In view of certain limitations of the facilities available in certain laboratories, my Council would be glad to advise any scientific colleagues who may wish to come and work in Australia as to which institutions can offer them the facilities required for their particular investigations.

L. H. R. CARNE
(Hon. Secretary).

Australian National Research Council,
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RESEARCH ITEMS

Biological Productivity of Lakes

IN studying the biological productivity of lakes, quantitative determinations of the standing crop of plants (producers) and of animals (consumers) have been made on several Wisconsin lakes by C. Juday, who described his results at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The ratio of plants to animals is not a static, but a dynamic, factor, which shows seasonal and annual fluctuations, as well as variations in shorter periods of time, especially with respect to the phytoplankton. The annual variations range from 10 : 1 to 15 : 1 when stated in terms of live weight. In soft-water lakes the ratio can be readily modified by the use of organic fertilizers, such as soy bean meal and cotton seed meal. The effect of these fertilizer fluctuations on the growth-rate of fishes is now being investigated. Manning and R. E. Juday (1941) found that the biological productivity of the upper stratum (epilimnion) of a lake is correlated, within certain limits, with the chlorophyll content of the phytoplankton. In terms of glucose, the computed productivity ranged from 14 to 44 kgm. per hectare a day in August in seven lakes.

Modification of Injury Produced by Röntgen Radiation

ATTEMPTS to modify the amount of injury produced by Röntgen radiation are of interest from theoretical and practical points of view. They indicate the importance of indirect effects of the radiation in the final injury to cells under certain conditions, and offer some hope of improving the tumour injury—tissue injury ratio in cancer therapy. Two types of experiments in which the radio-sensitivity of cells have been modified were described by T. C. Evans at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. It has been found that the effect of Röntgen radiation of decreasing the fertilizing power of Arbacia sperm is, within certain limits, proportionately increased as the concentration of the sperm in sea water (during irradiation) is decreased. The resistance of the sperm to this action of the radiation is greatly increased upon the addition of sufficient amounts of (1) dead sperm, (2) living sperm of Nereis, (3) egg albumen, (4) gelatin and (5) Arbacia egg jelly. Another line of evidence for the effect of the 'medium' on the radio-sensitivity of cells is derived from experiments on the skin of certain mammals. In these experiments it has been found that the resistance of the skin is increased when the circulation of the blood is blocked during the irradiation.

Heavy Carbon Isotope in Plant Metabolism

THE use of the heavy carbon isotope in studies of plant metabolism was discussed by R. Belkengren, A. O. Nier and G. O. Burr, of the University of Minnesota, at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The normal carbon dioxide of the air contains about 1·1 per cent of the carbon isotope ^{13}C. Using methane in a thermal diffusion column, the heavy carbon was increased to 5–10 per cent. This methane was burned to carbon dioxide and fed to green plants by photosynthesis. The accuracy of the mass spectrograph is such that the percentage of heavy carbon dioxide $\left(\frac{\text{mass } 45}{\text{mass } 44} \times 100\right)$ can be found to the second decimal place. Hence the amount of heavy carbon that has gone into any chemical fraction of the plant can be determined with fair accuracy even after considerable dilution. Young bean and radish plants were used for the experiments reported. When exposed to heavy carbon dioxide in darkness, the leaves of the bean seedling do not form a measurable amount of any diffusible compound that is transported and respired in other parts of the plant. However, in light the newly formed photosynthate is rapidly transported to all parts of the plant and incorporated at varying rates into every chemical fraction thus far examined. Within three hours root tips 30 cm. from the leaf are respiring heavy carbon dioxide, and after 24 hours the terminal centimetre of growing roots contains 30 per cent of the newly fed carbon. The conversion of newly formed photosynthate into chlorophyll, xanthophyll, lipids, cellulose, starch, protein, amino acids and amides has been measured.

A Trisomic Grasshopper

H. G. CALLON (*J. Hered.*, 32, 296–298 ; 1941) has found a trisomic individual of the grasshopper *Mecostethus grossus*, which is a rare species in Britain. There is usually only one chiasma situated near the centromere in each bivalent of *M. grossus*. Consequently, a trivalent is never formed in this trisomic individual, but the three homologous chromosomes are represented by a bivalent and a univalent. This univalent may be passive in the spindle similar to the *X*-chromosome, and may be included in one telophase group or it may, unlike the *X*-chromosome, be included in the spindle and remain near the equator until after the disjunction of the bivalents. As a result of this latter process, a diploid restitution nucleus is formed. The external appearance of the trisomic individual was similar to a normal male *M. grossus*.

Heparin

THE unit of early crude preparations of heparin, the blood anti-coagulant, originally found in liver and afterwards in most tissues, was defined as the minimum quantity necessary to keep 1 ml. of cat blood fluid for 24 hours at 0°. Units so defined in terms of some potentially variable animal reaction have not the advantage of units stated to be the specific activity contained in a fixed weight of standard preparation and measurable by any quantitative and standard biological test. Workers in Toronto have already proposed the crystalline barium salt of heparin as a standard having 100 units/mgm. F. C. MacIntosh (*Biochem. J.*, **35**, 770, 776 ; 1941) has now devised a simple method of test wherein oxalated horse plasma, to which heparin has been added, is recalcified in the presence of an excess of thrombokinase. The clotting time depends on the concentration of heparin. The method reveals differences in activity which are definitely greater than those determined for the same samples by methods using whole mammalian blood, and suggests that even crystalline barium heparin contains several individuals the activity of which appears to be unequally directed towards the different stages of the coagulation process. He also describes a colorimetric method for the standardization of heparin. Any high molecular weight sulphuric-acid ester will give a characteristic colour change when added to an aqueous solution of a metachromatic dye such as toluidin blue. The effectiveness of any substance in producing this colour change appears to be roughly proportional to its anticoagulant potency as obtained by the plasma-kinase method. A number of synthetic anticoagulants have thus been compared with heparin; for example, chlorazol fast pink and Bayer 205 (Germanin) have anticoagulant activities of the same order as heparin by the biological and colour tests, although their action may not be identical with that of heparin.

The Hindu Kush Earthquake of November 21, 1939

THIS earthquake has been studied especially by S. M. Mukherjee and A. R. Pillai, of the Colaba Observatory, Bombay ("The Hindu Kush Earthquake of November 21, 1939", by S. M. Mukherjee and A. R. Pillai, India Meteorological Department, Sci. Notes, 8, No. 91, pp. 85–90 + 2 pages of reproductions of seismograms). By Geiger's method of least squares, the epicentre of the earthquake was obtained at 36° 11′ N. and 70° 53′ E. The depth of focus was found to be 210 ± 14 km., which makes the earthquake a deep-focus shock. The hypocentral time is obtained as 11h. 01m. 43s. U.T. The authors note that there is a tendency for the Hindu Kush shocks to originate from very near the same focus, and also that this earthquake was recorded with initial compression at Bombay and the European stations, similar to most of the preceding shocks from the same epicentral region. It is remarked that the Hindu Kush earthquakes of a strong nature tend to occur in winter, while the weaker ones occur at all seasons. All these facts point to the possibility that all shocks from this region may originate from the same causes and by the same mechanism. The authors recognized the pulse *sP* at about 8°, the smallest epicentral distance for which seismograms were available. It is suggested that for the Hindu Kush earthquakes, a study of the *sP* phase may afford very reliable information concerning the epicentre and depth of focus of the shocks from the seismograms of a single Indian station. The desirability of more open time-scales on the seismograms is suggested.

The Microcoulomb Experiment

UNDER this title, Prof. F. Ehrenhaft has published (*Philosophy of Science*, **8**, 3; 1941) a résumé of his work, extending over thirty years, on the charges carried by minute solid particles in gases. It is recalled that, so long ago as 1909, using a method similar to that of the well-known Millikan experiment, Ehrenhaft obtained a value $4 \cdot 6 \times 10^{-10}$ E.S.U. for the mean charge on particles of colloidal silver. Certain particles, however, gave values for the charge considerably smaller, in some cases only one tenth of the electronic charge. The present article summarizes the very extensive and protracted researches carried out by the author, first at his Institute in Vienna, and later, after his expulsion from the Institute, abroad, into the genuineness of this effect. The charges have been studied in various forms of apparatus, both at normal and at high pressures. Particles of wax and selenium of perfect sphericity as viewed under the microscope have been prepared and studied. In order to avoid the uncertainties associated with the use of Stokes's law as a means of determining the masses of these minute spheres, Ehrenhaft has worked out a microscopical technique for the direct determination of their diameters, and produces evidence that the density of the particles is identical with that of the same substance in bulk. The mass is thus determined directly, without reference to the laws of motion through a viscous medium. The very ingenious microscopic technique is fully described in the paper. Prof. Ehrenhaft believes that the anomalous effects are genuine, and that in many cases the particles studied carry charges which differ from the fundamental electronic charge, or integral multiples of this charge, by amounts well beyond the limits of experimental error.

Sodium Arsenites

THE composition of the alkali arsenites is not very well established, in spite of the fact that very large quantities of sodium arsenite have been used in the past few years for the control of harmful insects; more than 7¼ million pounds were used in the United States in 1938–40 for three kinds of insects alone. O. A. Nelson (*J. Amer. Chem. Soc.*, 63, 1870; 1941) has made a phase rule analysis of the system containing Na_2O, As_2O_3 and H_2O, and the results show that solid phases of the following compositions separate: (1) Na_2O, $3As_2O_3$, (2) Na_2O, As_2O_3, (3) $2Na_2O$, As_2O_3, $7H_2O$ and (4) $2Na_2O$, As_2O_3. Of these, (1) and (3) were not previously known. The system was examined by Schreinemakers and De Baat in 1917 and some of their results could not be confirmed by Nelson, who gives reasons for supposing that these results are improbable.

XZ Aurigæ: An *N*-Type Variable

G. Alter and D. L. Edwards have issued a paper with this title (*Mon. Not. Roy. Astro. Soc.*, **101**, 5; 1941), which shows that this star is not a β-Lyræ type as recorded by Prager and Schneller. This discovery was made by an accidental comparison of a photovisual plate of a star field with the corresponding Franklin-Adams chart, when it was found that XZ Aurigæ was not present on the chart (limiting mag. 15), while it appeared on the Sidmouth photovisual plate as a star of magnitude 10. Further exposures showed that the star had a colour index of about $+4^m$, for which reason it was necessary to make fairly long exposure-times for photographic magnitudes to obtain a star image with the Mond Astrograph. Thirty-four comparison stars were chosen in the surrounding region, their magnitude range being large enough to exceed that of XZ Aurigæ in the photovisual scale, though not sufficiently large to secure the extension of the fainter photographic magnitudes, as the available apertures are too small. On three occasions only was it possible to secure both photographic and photovisual magnitudes, and the colour index was found to be $+3 \cdot 8$ to $+5 \cdot 0$. In view of this large colour index the 12-inch McClean objective prism was used to obtain the spectrum, but good photographs could not be taken owing to poor weather conditions and also to the fact that the star was close to the limiting magnitude obtainable with the instrument. The best photograph taken on March 30, although of poor definition, showed that the spectrum is almost certainly of late *N*-type—a view supported by the large colour index obtained. Wolf's observations, which were published in 1917, showed that the photographic magnitude was 14·5, and this is corroborated by the present investigation. It is remarkable that the colour index was found to change by about one magnitude in 10 days.

ASPECTS OF MODERN GEOLOGY

By PROF. EDSON S. BASTIN

University of Chicago

FOUR notable geological symposia were held on September 25 and 26 during the celebration of the fiftieth anniversary of the University of Chicago and with the co-operation of the Geological Society of America and the American Association for the Advancement of Science. All four symposia dealt with the frontiers of geological research.

The climax of the geological programme was undoubtedly the address of Reginald A. Daly, of Harvard University, on glaciation and submarine valleys. This was a remarkably lucid exposition of his hypothesis of the origin of submarine valleys by silty bottom currents or underflows operating under the general control of Pleistocene glaciation and its attendant effects on sea-levels.

Clay Materials

The first symposium, on the structure, properties and occurrence of clay materials and their practical application, was opened by Dr. Ralph E. Grim, of the Illinois Geological Survey, long a leader in clay research. Dr. Grim reviewed the old ideas of the composition of clay materials and the researches of the past fifteen years using modern research tools, that have led to the present generally accepted concept that clays are composed essentially of minute crystalline particles of one or more members of a few groups known as the clay minerals. The composition, structure and properties of these components were discussed and some new interpretations suggested.

Following this paper Dr. Sterling B. Hendricks, of the U.S. Bureau of Plant Industry, described in detail the lattice structure of many of the clay minerals.

Prof. W. P. Kelley, of the College of Agriculture of the University of California, discriminatingly reviewed the importance of clay researches to modern agriculture and emphasized the close relationship between soil science and geology.

Prof. F. H. Norton, of the Massachusetts Institute of Technology, pointed out that in addition to the clay minerals there are various mineral impurities, and that clays also contain soluble salts from the ground water which have a strong influence on their physical properties. Clay, having such a large surface, is very sensitive to adsorbed ions, and many of the variations observed in clays are traceable to this adsorbed material.

The symposium concluded with a discussion by Dr. Hans F. Winterkorn, of the College of Engineering, University of Missouri, of the importance of clay research in engineering construction, particularly of highways and dams, and the use of base-exchange and other methods for stabilizing such constructions.

Coals

The second symposium dealt with the physical constitution of coals and their practical significance and was under the leadership of Dr. Gilbert H. Cady, long in charge of the important coal studies of the Illinois Geological Survey. Dr. Cady pointed out that a satisfactory classification of coals into types must rest upon an understanding of the physical and chemical properties of the primary components of coal—vitrain, clarain, durain and fusain. Increased knowledge of these components has led to the important practical result that it is now possible to synthesize coals or modify them to conform to petrographical specifications.

Dr. H. H. Lowry, of the Carnegie Institute of Technology, reviewed the data on the chemical nature of the banded constituents of coals and emphasized the fact that essentially distinct types of chemical compounds peculiar to each of the banded components have not been found. Recent progress in Britain in the study of coals was reviewed by Prof. C. E. Marshall, of the University of Birmingham, who further emphasized the increasing importance of microscopic study of both the plant and the mineral components of coals to efficient utilization. That in the United States improved marketing and utilization practice based upon the newer knowledge of coal constituents is well under way was emphasized by Capt. Louis C. McCabe, of the U.S. Quartermaster Corps. In the coking of coals and in hydrogenization, knowledge of the coal components are also of great import as emphasized by George C. Sprunk, of the U.S. Bureau of Mines, who pointed out, for example, that the portions of coal that are translucent under the microscope are readily hydrogenized and give high yields of liquid fuels, whereas components that are opaque are difficult to liquefy.

The influence of metamorphism on the coal constituents was stressed by Dr. C. E. Dapples, of Northwestern University, who pointed out that some constituents such as cannel and durain tend to resist physical change, whereas fusain, clarain, vitrain and resinous bodies alter their physical properties with increase in rank.

Glacial Geology

The third symposium was concerned with the newer developments in the field of glacial geology, principally in North America, and was opened by Prof. Richard F. Flint, of Yale University. Several problems of very fundamental importance were discussed by him, one of these being the cause of the locations of the great ice caps. It has long been held that these ice caps grew *in situ*, but that hypothesis seems to encounter insuperable meteorological difficulties. It was pointed out that each central area of ice accumulation stands in definite relation to a high range of mountains—the Torngat Range of Labrador, the great mountains of Baffin Island, and the Swedish-Norwegian mountains, respectively. It seems likely that it was on these mountains that the snow fell, forming Alpine glaciers, and that these glaciers coalesced, growing outward away from the mountains and thickening to such an extent that they became high enough and cold enough to catch snowfall themselves, thereby shifting the locus of maximum snowfall away from the mountains, and eventually allowing the ice caps to bury the mountains.

Space does not permit the mentioning of all the contributions to this symposium, but the northern extent of glaciation in North America is certainly a matter of very general interest, and according to Dr. A. L. Washburn, of Yale University, this is still an unsolved problem the solution of which is handicapped by the fact that sea ice may produce some features which simulate the work of glacier ice. Recent field investigation indicates that Victoria Island, with an area of about 79,000 square miles, and the very much smaller Royal Geographical

Society Islands, were definitely glaciated during the Ice Age, and that glaciation of at least the southern portion of Banks Island is probable. Evidence obtained by a Canadian Government Expedition in 1908–9 suggests glaciation of Melville Island. No geological evidence seems to be on record indicating lack of glaciation on other islands in region. It appears that glaciation was derable areal importance in Canada's ctic, but informa- tion concerning areal extent must await fur Dr. D. A. Nichols, of the of Geology and Topography, that esent knowledge of the glacial geology has been gleaned incidentally to studies ler aspects of geology, notably the economic, and that great opportunities for specialized glacial studies exist. Correlation of glacial and marine features of the Atlantic Coast was considered by Prof. Paul MacClintock, of Princeton University, and the contributions of botanical studies to knowledge of post-glacial climates were presented by Prof. W. S. Cooper, of the University of Minnesota, who concluded that the record from pollen studies and the facts of plant geography apparently agree in indicating a mid-post-Pleistocene warm-dry period followed by a return towards cool-moist conditions during the last few thousand years.

Petroleum

The fourth symposium related to geological frontiers in the search for oil and was opened by A. I. Levorsen, chairman of the Research Committee of the American Association of Petroleum Geologists. Among the many interesting points brought out by Mr. Levorsen in his discussion of trends in petroleum geology was a point often overlooked by those interested in mineral resources, namely, that petroleum reserves contrast with reserves of other mineral resources in that it is impossible to estimate them in advance of discovery by drilling. Thus, whatever may be the *true* reserves, *estimated* reserves have always been small, and continued discovery is essential to continued development.

The role of modern surface methods in the search for oil was described by E. W. Owen, president of the American Association of Petroleum Geologists, and the role of micro-palæontology by Prof. Carey Croneis, of the University of Chicago. Dr. W. C. Krumbein, also of the University of Chicago, spoke of the importance of a fuller knowledge of the principles of sedimentation in the search for stratigraphic oil traps in contrast to structural traps.

In speaking of the role of ground water in petroleum accumulation, Prof. F. B. Plummer, of the University of Texas, concluded that recent extensive investigations of pore sizes, of the forces required to move liquid and gas hydrocarbons through them, of the variation in subsurface pressures, and of the forces due to interfacial tension, indicate that crude oil droplets cannot move through a porous sand from synclinal positions to anticlinal positions by gravity alone. The conclusion is reached that hydrocarbons migrate largely as gas particles and partly as liquid films enveloping gas bubbles, along with the slow downward movement of the ground water towards the lower part of the region, and that as the tiny gas bubbles come within the influence of decidedly low pressures they accumulate in the trap.

FOOD INVESTIGATIONS IN CANADA

FOOD studies constitute a very important field of research. In the National Research Laboratories at Ottawa nearly one half of the work in the Division of Biology and Agriculture now relates to food. Preparation, processing, packaging and preservation during transport are all subjects of research.

Since the autumn of 1939 the investigations in the food laboratories of the National Research Council have been directed almost wholly to new problems arising from the War. Among these is improved preservation of perishable products such as bacon and eggs shipped to Great Britain, the object being to overcome the effects of the longer shipping period and the lack of refrigerated space. The utilization of market poultry and other perishable products for which the export market has been reduced, and improvements in the nutritional value of canned goods and other processed foods have been studied. Special problems such as the storage of blood for transfusion, which the storage laboratories are well equipped to study, have also been given attention.

Poultry

One of the first problems undertaken in the food storage laboratories dealt with the preservation of dressed poultry in the frozen state. The results of this study led to definite recommendations as to pre-cooling, freezing, packaging and storage practices that should be followed to avoid impairment in appearance or eating quality. A new package was designed to facilitate moisture-proof sealing of the product in order to prevent deterioration from surface-drying during storage.

The use of the improved package for dressed poultry for export has been restricted owing to the shortage of refrigerated space on ocean-going vessels. This emphasized the importance of canning. A canning laboratory was established towards the end of 1939 and has now been almost completely equipped.

Following a preliminary survey of the canned poultry on the domestic market, improved methods of processing have been developed and their suitability to plant conditions demonstrated. The recommended processes include pressure pre-cooking, retort pre-cooking, improved methods of handling the raw and finished product and broth, and the use of side-opening cans, lacquered with a gold storing-type enamel which adds to the attractiveness without materially affecting the total cost. Attention has also been given to the development of a grading system, and apparatus has been devised for quantitative separation of the meat and jelly and for measuring the strength of the meat broth and jelly.

Another set of experiments was concerned with the development of rancidity in poultry fat during storage. Prompt pre-cooling and freezing were found essential to the preservation of quality.

Eggs

Eggs shipped to Great Britain in ordinary storage are subject to deterioration from the growth of micro-organisms on the exterior or interior of the eggs, desiccation through loss of moisture, and thinning of the 'thick' white through loss of carbon dioxide. Preservative treatments have been tested and methods of handling investigated. Oil dipping appears to be the most practicable commercial treatment. Canadian spray-dried whole eggs have been examined for export to Great Britain.

Pork

The frozen storage of pork is of considerable importance since the seasonal production of pigs in Canada demands that a considerable amount of pork must be placed in storage during peak seasons in order to maintain reasonably uniform export of bacon throughout the year. Studies have been made on colour changes and on development of rancidity in pork during storage.

Bacon

Investigations into the curing and transport of Wiltshire bacon, begun in 1938, have been continued as the major project in the food laboratories of the National Research Council. Before the War this work was extended to include comparative tests of Canadian and Danish bacon as received in Great Britain.

Wiltshire bacon is the most important perishable product which Canada exports to Great Britain during peace or war. Bacon studies undertaken before the War included a survey of the curing processes used in Canada. This disclosed variations in the method of producing Wiltshire sides in different plants. An extensive study of the bacon produced by these factories followed. The companies concerned co-operated actively with the National Research Council in these studies.

The results showed that the principal variation in Canadian bacon with respect to bacteriological, chemical and physical composition and such attributes of quality as colour, colour stability and tenderness was in the product manufactured in different factories. This indicated that differences in the curing process, rather than the differential response of individual carcasses to curing, were the primary cause of variable quality. The market value, of course, is also affected by the preference of consumers for sides of a certain conformation.

In recent months more emphasis has been laid on methods for converting the extremely perishable unsmoked bacon normally shipped to England into a form that will withstand the delays in transport while maintaining the highest possible quality. It has been found that smoked bacon is less perishable than the unsmoked material. The possibility of smoking the product in Canada, and the use of cures that render the product less perishable are being investigated.

Smoking is almost universally used in the processing of bacon but Canadian Wiltshire sides have hitherto been exported to Great Britain in the 'green' or unsmoked condition and smoked there. It is generally accepted that smoking has a preservative action but little information of a quantitative nature is available. Extensive studies have therefore been undertaken on the relative perishability of smoked and unsmoked bacon as judged by colour measurement, peroxide oxygen content of fat, and surface bacterial counts. In the storage studies unsmoked bacon was found to be rancid after forty-two days, whereas the smoked product was usually satisfactory after seventy days.

Wiltshire bacon is usually matured for two or three weeks before smoking and then consumed immediately. This procedure is believed to produce the most desirable flavour. If smoking were employed as a method of preservation during transit, the material would have to be smoked shortly after cure and then be carried through a relatively extended transport period before reaching the consumer.

As regards the research on Wiltshire bacon, it may be noted that twenty-three papers on this subject have been published in the *Canadian Journal of Research*. These papers have dealt with such subjects as: a survey of Canadian plant and curing processes; distribution of chloride; effect of heat treatment on nitrite co[illegible] colour and toughness; measurement of the colour [illegible] seasonal variations in colour; bacteriological and [illegible] during cure; the effect of temperature [illegible] nitrite content, etc. Further work [illegible] to be curtailed in favour of work [illegible] of methods of preservation of bacon [illegible] Great Britain.

Influence of Conditioning Factors

Precise control of temperature, humidity and other factors are frequently necessary for the storage and freezing of foodstuffs. Earlier investigations into the humidification and the reduction of temperature variations in cold stores have been continued. Apparatus has been developed for the measurement and control of humidity in cold stores.

Blood Storage

Shortly after the outbreak of war, certain problems relating to storage of whole blood were referred to the Division of Biology and Agriculture by the Sub-committee on Blood Storage of the Associate Committee on Medical Research. The object of these studies was to determine the conditions under which human blood could be stored for the longest possible period. This work has been completed.

Vitamin Fortification

Current attempts to raise the nutritional level of the population, including the vitamin-fortification of certain foods, have emphasized the need for information on the effect of processing and storage treatments on the vitamins, several of which are destroyed by exposure to air or by high temperature. Methods and equipment for studying these problems by chemical means are being developed.

The vitamin B complex contains at least two components that can be determined chemically by means of a fluorimeter. Such an instrument has been designed and constructed. It is cheap, simple, self-contained, stable in operation and is capable of measuring thiochrome (produced from thiamin or vitamin B_1) in concentrations as low as one part per hundred million.

Many other investigations relating to foods are under way in the laboratories of the National Research Council or in other laboratories under the programme of work decided upon by the Canadian Committee on Storage and Transport of Food.

Special mention may be made of the development and testing of improved methods of controlling temperature in refrigerated cars. In this work the Division of Physics and Electrical Engineering co-operated by designing the necessary apparatus, and the Fisheries Research Board successfully carried out test shipments of frozen fish from Prince Rupert to Montreal.

Detailed accounts of investigations in food storage and transport are contained in papers published in the *Canadian Journal of Research* and in the annual review of activities issued by the National Research Council of Canada.

RESPIRATION AND THE ASSIMILATION OF CARBON DIOXIDE

AN account of work by C. H. Werkman, L. O. Krampitz and R. G. Wood of Iowa State College on the assimilation of carbon dioxide during respiration was given on October 13 during the Autumn Meeting of the U.S. National Academy of Sciences.

The concept of heterotrophic assimilation of carbon dioxide was first established in 1935 by Wood and Werkman, while investigating the dissimilation of glycerol with the propionic acid bacteria. They observed the molar correlation between carbon dioxide disappearance and succinic acid formation and proposed the reaction: pyruvate + CO_2 → oxaloacetate, to account for this fixation of carbon dioxide. The latter four-carbon dicarboxylic acid serves as the oxidizing agent for the glycerol, resulting in the formation of succinic acid.

The concept of carbon dioxide assimilation has recently been applied to many other heterotrophic forms, including the liver tissue of mammals. It is in this tissue that the role of carbon dioxide fixation has been shown to be of fundamental importance with regard to respiration. Oxaloacetate is the cardinal compound in the main respiratory mechanism of the tissue. Consequently elucidation of the mechanism of its formation is of fundamental importance. Direct evidence for the fixation reaction has been obtained with a bacterial enzyme preparation from *M. lysodeikticus*, which is capable of bringing about the decarboxylation of oxaloacetate, that is, the reverse of fixation reaction. Thus far attempts to carboxylate pyruvate have failed. This may be due to an unfavourable equilibrium, that is, the breakdown of oxaloacetate is greatly favoured. On the other hand, pyruvate as such may not be the compound with which carbon dioxide unites but rather a derivation of pyruvate. With ^{13}C as a tracer it was possible, however, to demonstrate the fixation reaction using oxaloacetate. Decarboxylation of oxaloacetate was carried out in the presence of the enzyme and $NaHCO_3$ with an enriched ^{13}C content. The reaction was allowed to continue until the original oxaloacetate concentration was halved. The residual carbon dioxide was removed and the remaining oxaloacetate was decarboxylated to pyruvate and carbon dioxide and the latter thus obtained determined for ^{13}C. The concentration of ^{13}C was substantially above normal.

The criticism that a chemical exchange of carbon dioxide with carboxyl group, analogous to the exchange of deuterium with ionizable hydrogen, may take place was investigated. Oxaloacetate spontaneously decarboxylates slowly. An experiment similar to the above one was performed omitting the enzyme, and the residual oxaloacetate decarboxylated. The ^{13}C content of this carbon dioxide was normal.

The possibility of the enzymatic exchange of carbon dioxide with carboxyl groups of other keto acids was investigated, with an enzyme capable of oxidizing pyruvate to acetate and carbon dioxide. An experiment was conducted in which the oxidation was permitted until one half of the pyruvate remained. The residual pyruvate was decarboxylated and the ^{13}C content of the carbon dioxide was found normal. Similarly, the oxidation of α-keto glutarate to succinate was carried out, and likewise the normal ^{13}C content of carbon dioxide obtained.

Thus it has been demonstrated that the exchange reaction is specific for oxaloacetate, and apparently does not occur in other keto acids. The exchange reaction in oxaloacetate is essentially 3- and 1-carbon addition or a fixation reaction.

GAME PRESERVATION IN BURMA

THE annual report on game preservation in Burma for the year ending March 31, 1940 (Rangoon, Supt. Govt. Printing, Burma, 1941) shows that this matter is treated in Burma with the serious spirit it demands. The present policy aims at providing a sufficient number of sanctuaries to ensure that no species of Burman bird or animal becomes extinct. The following list of sanctuaries will indicate how this laudable effort is carried out under the able game warden, a member of the Burma Forest Service. It is a pity that India as a whole and the British Colonies have not made similar attempts at game preservation. There are seven sanctuaries situated in North and South Burma: Pidaung (Myitkyina), 278 sq. miles; Shwe-u-daung (E. Katha), 81 sq. miles, with another 45 sq. miles situated in the neighbouring Federated Shan States; Maymyo (summer headquarters of Government of Burma), 49 sq. miles; Moscos Islands (Tavoy), 19 sq. miles; Kahilu (Thatôn), 62 sq. miles; Mulayit (Thaungyin), 53 sq. miles; Wetthigan (Minbu), 1¾ sq. miles.

The Pidaung sanctuary is primarily constituted to protect elephants, bison, saing, sambhur, hog deer, pig, tiger, leopard, bear, pea-fowl, pheasant, jungle fowl, partridge and quail. Of these it is reported that elephant, bison and saing continue to increase, though elephants only spend part of their time in the sanctuary. On the other hand, there is a marked reduction in sambhur and hog deer found in the open plains; this is attributed to tigers and wild dogs. Four tigers are to be shot by the keepers of the sanctuary and as many wild dogs as possible, as also crows which are a serious pest to bird life in the sanctuary. Those acquainted with big-game shooting in India must have noted at times the results of the wild dog pest—whole jungles deserted by game once the animals are aware of the advent of parties of wild dogs.

The Shwe-u-daung sanctuary contains the above mentioned fauna, with the addition of *Rhinoceros sumatrensis* and the serow. There is reason to believe, says the warden, that the small band of Sumatran rhinoceros living in this sanctuary has become well established, and the evergreen hill forests covering the upper slopes of the sanctuary provide an undisturbed area where these animals can live in peace. The increase in wild dogs is giving trouble here. In the Kahilu sanctuary the animals are *Rhinoceros sumatrensis*, serow, sambhur, barking deer, mouse deer, hog deer and jungle fowl. It has been proved that the rhinoceros in this sanctuary is *R. sumatrensis* and not *R. sondaicus*, as identified some years ago from skulls by the Bombay Natural History Society. The Sumatran rhinoceros is an extremely rare animal in Burma.

Of the other sanctuaries the Maymyo contains barking deer, jungle fowl, partridge and pea-fowl; Moscos Islands, sambhur, barking deer and pig; Mulayit, barking deer, pig, tiger, and leopard; and the latest made sanctuary, the Wetthigan, which includes the lake of that name for the preservation of numerous indigenous and migratory waterfowl, of which thirty-three resident species and thirty-one migratory species have been identified.

It is of interest to hear that the reservation of other sanctuaries is under consideration. The only cause for alarm is the warden's statement that "there is at present no co-ordination between the civil authorities who are responsible for the issue of fire-arms and ammunition, and the Forest Department which is mainly responsible for the protection of wild animals and birds". It is to be hoped that this defect in a far-sighted policy may be removed.

IRISH FISHERIES

THE quantity of sea fish landed in Eire during 1939 was larger than that landed in any year since 1931, and its value reached the highest figure since 1929 (Department of Agriculture (Fisheries Branch). Report on the Sea and Inland Fisheries for the Year 1939. Dublin, Published by the Stationery Office). The increased landings in 1939 were due to heavier catches of demersal fish by the stream trawlers operating from Dublin, and of mackerel by inshore fishermen on the County of Kerry coast-line. The total catch of whiting in 1939 seems to be the highest recorded for the country, and landings of prime fish, cod and hake, were the heaviest for several years. The quantitative yield of the herring fisheries was less in 1939 than in 1938, but its total value was greater by £5,000. The decrease in quantity was due to the failure of the summer fishery of the north-west coast. The substantial increase in the mackerel landings was due to heavier catches in the autumn mackerel fishing off the south-west coast.

The S.S. *Muirchu* took part during the year in scientific cruises off the north and south-west coasts of Ireland. The cruise off the south-west coast was undertaken in April 1939 for the purpose of continuing the mackerel investigations begun in 1938 in collaboration with the English and French research vessels. As in the previous year mackerel eggs were found in large numbers in an area thirty to seventy miles south to south-south-west of the Fastnet Light. Hydrographic and plankton observations were the main purposes of the cruise off the north coast.

In the inland fisheries the salmon fisheries in 1939 improved but slightly in quantity compared with the years 1937 and 1938, both of which were bad years also for other countries in Western Europe. There was a lack of small and large spring fish such as have spent two or three years respectively in the sea. This was partly compensated for in some parts of the country and particularly in the west by a very good run of grilse.

Artificial propagation of salmon and trout continues; but owing to weather conditions the quantity of ova available was below normal. At the brown trout hatchery at Lough Owel, in spite of weather, there was a record output of 560,000, some of which were returned to the Lough in the fry stage and others distributed among other stations throughout the country.

Scientific investigations into the age and growth of salmon and other salmon researches are in progress. Seventeen appendixes, mainly statistical, are included in the report.

FORTHCOMING EVENTS

Saturday, January 3

JOINT MEETING OF TECHNICAL INSTITUTIONS arranged at the request of the Mines Department (in the H. H. Wills Laboratory, Royal Fort, Bristol), at 2.30 p.m.—Discussion on the Best Ways and Means of Improving the Efficient Use of Fuel and Power in Existing Industrial Plants, under Present Conditions, and to Invite Constructive Suggestions. (To be opened by Mr. J. G. Bennett.)

Monday, January 5

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m. —Dr. C. A. Freak: "Insecticides".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Mr. Patrick FitzGerald: "The Lake Basin of Tali, Yunnan".

Thursday, January 8

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Dome Lounge, Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—Mr. George Hicks, M.P.: "The Part of the Ministry of Works in Post-War Reconstruction".

Saturday, January 10

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Federation of British Industries, 21 Tothill Street, London, S.W.1). Dr. W. Wilson: "Recent Developments in the Design and Application of the Cathode Ray Oscillograph".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EDUCATIONAL PSYCHOLOGIST in connexion with the Child Guidance Clinic—The Director of Education, Education Offices, 15 John Street, Sunderland (January 9).

LIBRARIAN (WOMAN)—The Principal's Secretary, Royal Holloway College, Englefield Green, Surrey (January 10).

ELECTRICAL ENGINEER under the Engineer-in-Chief—The Secretary, Tyne Improvement Commission, Newcastle-upon-Tyne 1 (endorsed 'Electrical Engineer') (January 12).

RESEARCH ASSISTANT TO UNDERTAKE WORK ON HOT-TINNING—The Secretary, Tin Research Institute, Fraser Road, Greenford, Middlesex (January 17).

HEAD OF THE PHYSICS DEPARTMENT—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (January 17).

EDUCATIONAL PSYCHOLOGIST, a MEDICAL DIRECTOR and PSYCHIATRIST, and a PSYCHIATRIC SOCIAL WORKER, in connexion with a Child Guidance Clinic—The Director of Education, Municipal Building, Preston (January 17).

GARDINER CHAIR OF CHEMISTRY—The Acting Secretary, University Court, The University, Glasgow (February 8).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Tin Research Institute. Publication No. 106: The Longitudinal Ridged Structure in the Tin Coating of Tinplate. By Dr. B. Chalmers and W. E. Hoare. Pp. 8+1 plate. (Greenford: Tin Research Institute.) [1012

Other Countries

Smithsonian Miscellaneous Collections. Vol. 99, No. 22: The Ice Age Problem. By Walter Knoche. (Publication 3633.) Pp. ii+5. (Washington, D.C.: Smithsonian Institution.) [2511

Transactions of the San Diego Society of Natural History. Vol. 9, No. 27: The Distribution of Pocket Gophers in Southeastern California. By John E. Chattin. Pp. 265–284. (San Diego, Calif.: San Diego Society of Natural History.) [312

University of California Publications in Zoology. Vol. 44, No. 2: A Field Study of the Growth and Behaviour of the Fence Lizard. By Henry S. Fitch. Pp. 151–172. 25 cents. Vol. 44, No. 3: Speciation in the Avian Genus Junco. By Alden H. Miller. Pp. 173–434. 3 dollars. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) [312

Smithsonian Miscellaneous Collections. Vol. 99, No. 23: Evidences of Early Occupation in Sandia Cave, New Mexico, and other Sites in the Sandia-Manzano Region. By Frank C. Hibben. With Appendix on Correlation of the Deposits of Sandia Cave, New Mexico, with the Glacial Chronology, by Kirk Bryan. (Publication 3636.) Pp. vi+64+15 plates. (Washington, D.C.: Smithsonian Institution.) [312

Records of the Botanical Survey of India. Vol. 14, No. 2: A Revision of the Indo-Malayan Species of *Glycosmis correa*. By V. Narayanaswami. Pp. v+72+ii. (Delhi: Manager of Publications.) 4.6 rupees; *7s.* [412

Indian Forest Records (New Series.) Botany, Vol. 2, No. 2: *Thyrsostachys oliveri* Gamble. By Dr. N. L. Bor. Pp. 217–226+2 plates. 10 annas; 1*s.* Entomology, Vol. 6, No. 9: Immature Stages of Indian Lepidoptera (3). By J. C. M. Gardner. Pp. 297–314+1 plate. 12 annas; 1*s.* (Delhi: Manager of Publications.) [412

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BACKGROUND TO NATIONAL PLANNING

THE need for reconstruction, using the word in its largest sense, is world wide. Nevertheless, it must be realized that in many ways, as Mr. Anthony Eden implied in his broadcast talk on January 4 dealing with his recent visit to the U.S.S.R., the internal affairs of any country are peculiar to that country. Schemes of reconstructions suitable for one country might therefore not be appropriate elsewhere. Here it is proposed to consider recent literature dealing with the subject in Great Britain.

The summary report recently issued of the Oxford Conference of the Town and Country Planning Association* held last spring emphasizes, if that were needed, that the value of the Conference would emerge over a period, rather than in tangible results registered during the week-end. The volume makes available for the first time a clear and comprehensive account of the six sessions and relates them to the main aim of the Conference, namely, to crystallize and carry a stage further the national planning policy outlined in the nine agreed points of the Report of the Royal Commission on the Distribution of the Industrial Population. In doing so it provides an admirable yardstick by which progress can be measured, and in this respect can well be compared with Gilbert and Elizabeth McAllister's "Town and Country Planning" (see NATURE, Sept. 27, p. 353).

The need for such a background in considering the approach to post-war reconstruction, as well as for something of a yardstick for assessing progress, tends to grow rather than diminish. Such a measuring rod is essential in maintaining a sense of perspective in the growing literature of pamphlets, many of which are wholly admirable, and of the reports and studies of special aspects of the subject which are now appearing. It is also invaluable in assessing the actual proposals which may be formulated by the Government in the Bill to implement some of the findings of the Uthwatt Committee, and by local or professional authorities or institutions. The background provided by volumes of the type of the report of the Town and Country Planning Association is essential for the development of the principles by which the new pattern must be constructed and individual contributions assessed.

One of the happiest efforts to provide such a background has been Mr. F. J. Osborn's "Overture to Planning" in the Rebuilding Britain Series†, in which he emphasizes the need for clarifying standards of planning before they can be applied by a central department, as well as the necessity for founding planning firmly in the permanent needs of humanity. Towns must be shaped to answer to the needs of the family and industry and of the social life which enfolds them. Accordingly, it is imperative that there should be a clear idea of the new social pattern in which reconstruction will take place and of the several planes of social organization—the individual, the family, the local community, the region, the nation, and the commonwealth or family of nations.

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* Replanning Britain : Being a Summarized Report of the Oxford Conference of the Town and Country Planning Association, Spring 1941. Edited by F. E. Towndrow. Pp. 173. (London : Faber and Faber, Ltd., 1941.) 7*s*. 6*d*. net.

† Overture to Planning. By F. J. Osborn. (Rebuilding Britain Series, No. 1.) Pp. 29. (London : Faber and Faber, Ltd., 1941.) 1*s*. net.

The broadsheet "The New Pattern" in which such ideas are developed is one of the many valuable contributions which Planning (P E P) has made to the problem of re-integration and to planning for reconstruction which really meets contemporary needs and in which the several parts form a harmonious whole. In a more limited sphere the same conception inspires a pamphlet "Britain Must Rebuild" in the Democratic Order Series by Mr. Frank Pick*, whose death will be a great loss to Great Britain. While nothing short of regional planning offers the opportunity for a stable settlement, even deeper than the need for new demographic survey is that for an understanding of the social unit upon which democracy is to be built. That unit must involve all classes and carry within it no class distinction. Mr. Pick believed in the need for a correct and natural conception of the social unit, without which the social structure cannot be secure, and he emphasized the distinction between town and country. There must be a radical break between town and country; neither can be fittingly or properly built up until the social unit is defined.

This stress on the place of agriculture in planning policy—the insistence that as a first step no land may on any account be taken out of agriculture, and no land suitable for agriculture may be used for any other purpose—is a reminder that the necessity for planning agriculture for food supply makes some concrete measure of reconstruction and planning in the relations of town and country essential. Without at least the negative approach of resolute prohibition, neither utility nor amenity will be served in country or in town.

It would be unfair to characterize Mr. Pick's pamphlet as negative, but it is full of warnings as to the dangers which attend a policy of neglect or drift. A definite change in the national attitude must at some moment be realized, and the introduction of the expected Reconstruction Bill may well be the moment. Beyond the details of compensation and betterment, the interests of the people must override the interests of the owners, and a sharp, firm line must be drawn and maintained; the needs of agriculture, amenities and recreation must be provided for before we turn to planning and the location of industry, as "Replanning Britain" abundantly makes plain.

In regard to industry, Mr. Pick insists on the concentration and not the dispersal of industry, taking the trading estate as the model. He advocates compact housing and a new approach to regulation which eliminates fixed by-laws but visits severe penalties on the builder who tries to slip through them. The basis of any plan for rebuilding Britain is transport, and here again Mr. Pick concentrates attention on the function and purpose which the road or street is to serve, and on designing it to that end, subservient to the plan or scheme for the region. He visualizes the railway station as a nuclear point and stresses the conception of the city as a social organism, the vital organs of which should be aptly placed and proportional to the work they have to do. The awkward problem of blending town and country is met by a device of wedges of park and wood tapering inward and of houses and buildings tapering outwards around the central core.

In the planning of cities and towns, site control, sentimental fondness for the old, and the lack of an architectural style are still the three major difficulties. In regard to the first, the recommendations of the Uthwatt Committee have already indicated the line of advance. The second difficulty is being shattered by enemy bombardment as well as by the general disturbance of civil life caused by evacuation, dispersal of industries and the like. The third difficulty is one primarily for the architect through his professional associations, though not for him alone. The clients as well as the architects need education and imaginative insight if we are to develop a living architecture which finds expression in appropriate cultural forms in all the new and old materials which now are to our hand.

Mr. Pick had very clear ideas on the danger inherent in functional building, on the importance of planning the countryside, including its buildings, as country, the treatment of farms and the necessity of clearing away the ruins of decayed industry as well as of avoiding either sectional settlement of building or the tyranny of the expert or bureaucrat. He gives us a vision of the possibilities once we have chosen a pattern and address ourselves resolutely to the co-operative task of achieving it; and his concluding suggestion regarding the classification and labelling of buildings according to their fitness and suitability, if not of architectural merit, might well supply a practical incentive at little cost to better planning and building.

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* Britain Must Rebuild: a Pattern for Planning. By Frank Pick. (The Democratic Order, No. 17.) Pp. 64. (London: Kegan Paul and Co., Ltd., 1941.) 1s. net.

The work of educating public opinion and clarifying the issues is clearly proceeding apace, and on the whole it is probably true that in this, as in some other fields, such as production, opinion is ripe for much more drastic and resolute action than the Government has yet proposed. Moreover, not merely are the principles and background of planning being vigorously explored, but also much of the detailed investigation incidental to the framing or execution of any reconstruction plans is being actively pursued. Already three interim reports have appeared from the Reconstruction Committees of the Royal Institute of British Architects, and a recent report of the Association of Architects, Surveyors and Technical Assistants makes a further contribution in this field.

The first of the reports of the Royal Institute of British Architects deals with planning and amenities, and reiterates the arguments in favour of a national planning authority. For post-war operation, any plan must be mainly constructive rather than restrictive in character, and for this reason the present exemptions from planning are undesirable. As the recent P E P broadsheet on "Publicly Owned Land" indicates, although the Forestry Commissioners, the Duchy of Lancaster, and the Commissioners of Crown Lands are not subject to the existing planning Acts, in practice they consult or co-operate with local planning authorities. Nevertheless there is much to be said for bringing the Crown lands and all other State-owned lands within the purview of the planning Acts in the normal way.

The interim report of the Royal Institute of British Architects indicates the machinery essential for a national plan, and the matters with which experts responsible for the preparation of such a plan must be concerned. The national authority should include the Ordnance Survey, at present under the Ministry of Agriculture; the value of a new map on a scale of about three inches to the mile for the purpose of a national plan, fully contoured, is stressed. The authority should include the present planning department of the Ministry of Health, but not the detailed work of housing, the trunk roads and new roads, at present dealt with by the Ministry of Transport, as well as railways, ports, canals and public utilities, essential agricultural reservations, national and regional open spaces, approval and reservation of aerodrome sites. It should be supported by regional offices to deal promptly with these matters on lines laid down by the central authority as well as by regional groupings of the local authorities, which will decide as to suitable local planning areas and any necessary financial adjustments.

This outline alone indicates how important a contribution the establishment now of a national planning authority might well make not merely to post-war reconstruction but also to the co-ordination of our war effort.

This is equally true of the proposals, in the second interim report, on war-time housing, and in the report issued by the Association of Architects, Surveyors and Technical Assistants. Both these reports emphasize the way in which present and post-war needs are related and the importance of greater co-ordination among the authorities responsible for war-time housing. The report of the Royal Institute of British Architects recommends that in new *war-time* housing the single-family *peace-time* standard house should be abandoned in favour of hostel dwellings providing minimum living and sleeping accommodation with communal facilities for feeding, heating, washing and relaxation. The choice between permanent and temporary types of building should be governed by long-term as well as by immediate considerations. Of the permanent types, two- or three-storied structures should be built with the maximum amount of standardization, and this accommodation should be designed so as to provide for conversion later to peace-time housing standards.

The same conception of new housing of a permanent nature designed to give a high degree of protection, standardized to ensure speed of erection and utilize unskilled labour and capable of being adapted later as family homes and post-war housing is found in the Association of Architects, Surveyors and Technical Assistants' report, "Why Wait for the Blitz ?". Much of this report is concerned with provision of rest centres and feeding-centres in and outside the towns, and with the administrative work required, including the establishment of regional councils representing local authorities, trades' councils and Government departments, with full powers to execute schemes and to organize pools of labour and materials on a regional basis. It also includes a description of the blast- and splinter-proof housing devised by Mr. O. N. Arup in the scheme prepared for Clydeside to illustrate how it can be converted to a peace-time housing design.

The advantage of designing new war-time buildings to serve post-war needs in this way is obvious, but it may be lost entirely unless such construction is planned in harmony with long-term national and not merely sectional needs. Similar considerations give urgency to the recommendations in the Royal Institute of British Architects' first report regarding the control of design and the immediate investigation of the possibilities in the distribution of hot water and heat on an area basis, the saving of waste and salvage of useful material, the utilization of spoil heaps, disposal of refuse matter on a mechanical basis and the avoidance of atmospheric pollution. Moreover, as the Committee points out, investigations into many aspects of both urban and rural life, such as rates and rating, public and private roads and public ownership of land are essential as a preliminary to the legislation which is already recognized as inevitable.

Since the publication of the Uthwatt Report, the memorandum on compensation and betterment submitted to that Committee by a special committee of the Royal Institute of British Architects has been published in the *Journal* of the Institute. This suggests a method of dealing with this difficult problem which will at the same time be fair to owners and retain the essential of private initiative. Like all other proposals, it insists on a plan as the first essential, and that all land should be deemed to be covered by a planning resolution. For developed land suitable areas can be readily defined for special rating for special improvements, but for undeveloped land the theory of the acquisition of development rights is unacceptable, and if any form of nationalization is to be considered it must not be allowed to be the subject of long years of argument and negotiation.

The really significant feature in the present situation is indeed, as the PEP broadsheet points out, that the question of land ownership and management has been taken to a remarkable extent out of party politics and is being considered on its merits. It is at last possible to tackle the problems of agricultural and urban land on something of a rational basis and to outline the beginnings of a twentieth-century land policy for Great Britain as a whole. This much has been achieved as a result of the PEP report on the location of industry, the Barlow Commission report and the combined effect of submarine warfare, which brought home the folly of neglecting farm and forest land, and bombing, which has at last compelled Parliament to consider extricating the cities of Great Britain from the strait-jacket of an anachronistic system which should long since have been recast.

That the Government is alive to the relation of agriculture and the reconstruction of town and industry is shown by some of Lord Reith's utterances, as well as by Mr. Greenwood in his introduction to the McAllisters' book, or indeed by Mr. Hudson's recent statement in the House of Commons regarding speculation in agricultural land and the issue of a defence regulation to prevent such speculation. That regulation is designed to prevent fresh obstacles arising to the acquisition or scheduling of land for planning purposes, and at the same time to avoid disturbance to the campaign for increased home food production. The scanty reference to such matters in the King's speech at the opening of Parliament, however, may well indicate that it will require all the interest and force of intelligent public opinion to ensure that legislation is not unduly delayed, and that it gives full expression to the hopes which have already been aroused, and uses to the full the opportunities which the War has brought.

Moreover, the third and most recent report of the Royal Institute of British Architects' Reconstruction Committee, on structural building legislation, indicates further directions in which immediate legislation is required. Its first recommendation is the establishment of one national building code for the whole country, formulating, on a scientific basis, standards of stability, fire resistance, and methods, details and materials of construction. There should be in London one central office for general administration with local administration of the national building code. The final and most important recommendation is the setting up forthwith of a national building board as an independent authority responsible to Parliament without being incorporated in the machinery of a Government administration. This board, which might be developed from the Building Research Board and the British Standards Institution, would be responsible for developing a national building research organization, the direction and co-ordination of research on materials and methods of construction and the formulation of the national building code.

These are constructive proposals, though it may be open to doubt whether such a board should not be part of the central planning authority. In this matter of reconstruction and of replanning Britain, however, education, inquiry and action must proceed side by side. Public opinion has already been prepared for advances, and is becoming aware of the importance of land policy and its possibilities. Whether in the war years we are to lay the foundations of a constructive policy of planning town and country side by side, which will use those opportunities and enable us after the War to build a new and healthier Britain, the towns and countryside of which will serve the needs of the new social pattern and contribute to new standards of health and nutrition and living and economic security, depends on whether we bring now to that task the courage, vision and knowledge it requires. The report of the Oxford Conference of the Town and Country Planning Association is a substantial contribution to that task of education. Although it may bring to the scientific worker little in the way of new knowledge, it should at least stimulate him to take a larger share in the task of educating his fellow-citizens, a task which must proceed side by side with the numerous investigations already attempting to gather the detailed facts and knowledge upon which alone a national planning policy can be based.

BRITISH BIRDS

The Handbook of British Birds
By H. F. Witherby (editor), Rev. F. C. R. Jourdain, Norman F. Ticehurst and Bernard W. Tucker. Vol. 5 (Terns to Game-Birds) (Additions and Corrections) (Systematic List and Indices). Pp. xii+356+22 plates. (London: H. F. and G. Witherby, Ltd., 1941.) 25*s*. net; complete in 5 vols., 105*s*. net.

THE final volume of the "Handbook of British Birds" has now made its appearance, and it is pleasant to see that the high standard attained by the preceding four volumes has, if possible, been exceeded in this latest book with its handsome binding, clear print, and excellent illustrations. The editors are to be congratulated on having succeeded, despite the great difficulties of the times, in completing a work on birds which is without a rival not only in Great Britain but also throughout the world.

Terns to game birds are described in the present volume under review, and there is also a carefully compiled list of additions and corrections to previous volumes.

The first bird in this volume—the black tern—is of unusual interest, since, up to the middle of last century and even later, it continued to nest in the Fens of England. It is still seen, each spring and early summer, frequenting its former haunts for a few days while on passage to Belgium and Holland, Denmark and the Balkan States.

The common tern at its summer haunts is a bird of two distinct habits: it may nest in large colonies on the coast, or may breed in pairs along the shingly stretches of the Dee, Spey and other Highland rivers. On the Dee I have seen it nesting beyond Ballater—that is, as the river flows, fifty miles from the sea. A point which I have noticed is that these single terns are much more timid at their nesting haunts than the colonies which nest on the coast, and will not fly down to their eggs so long as they believe a human observer to be in sight of them. One difference between common and Arctic tern is the colour of the bill. In the common tern it is orange-red with black tip: in the Arctic tern it is blood-red throughout, and has no black tip. The Arctic tern's alarm note is shorter and harsher than the corresponding call of the common tern, and when on the ground the Arctic tern is seen to be shorter-legged.

The sudden flights out to sea of common terns (p. 29) during the nesting season is discussed. These periodic flights, during which the clamour of the nesting colony is suddenly hushed and all the birds fly in complete silence out to sea a little way before swinging in again and returning, still in silence, arise from some cause not yet understood. G. and A. Marples in their "Sea-Terns" (pp. 169—172) attribute the flights to sudden fear, of obscure origin. Arctic terns also make these flights, and so do kittiwake colonies. My own impression is that these aerial excursions are due to a sub-conscious migratory impulse. Certainly the flights become more frequent as the nesting season advances and as the August day approaches when, leaving belated eggs and immature young of various sizes to perish, the colony as one bird rises into the air and sets out towards the south.

The black tern is easy to identify, but there are many bird students who are not sure of the differences between common and Arctic tern. The full and careful descriptions of these two species, and the means of distinguishing them, are therefore valuable. The same remark applies to the rare roseate tern.

In the auk section of the volume the authors have been at pains to work out the distribution (p. 156) of the ringed or bridled variety of the common guillemot. In the eastern Atlantic there is a general tendency of increase in the bridled variety northward, and to a less extent westward, with some exceptions. Thus in the Portuguese colonies of these birds bridling is not recorded, while in France the figure is as low as 0·1 per cent. In Heligoland and the Baltic the figure is mainly between 1 and 2 per cent, as in the southern British Isles. In Shetland colonies this figure is greatly increased, and a further increase is found in the Faeroes, where the bridled variety form 34 per cent of the colonies. On the Westmann Isles, off the south coast of Iceland, bridled guillemots form 52·7 per cent of the colonies, but off the north of Iceland, on Grimsey, the figure falls, curiously enough, to 8·7 per cent.

Of the great autumn migration of the common guillemot south-westward through the Minch something might be said, the birds passing daily in thousands throughout the month of October.

The black guillemot (p. 163) would appear to be more sedentary in habit than the common guillemot. To the 'food' of this species might be added small conger eels and small flat fish.

A considerable proportion of the volume is devoted to the gull tribe.

In the account of the distribution of the large Arctic-nesting glaucous gull (p. 109), I am reminded that I have seen this gull on the River Dee in Aberdeenshire when fishing in early February at the opening of the salmon season. At this time of the winter a considerable number of kelt salmon have died after spawning. These fish are lying on the river banks, or in shallow water, and great black-backed gulls habitually enter the river valley to feed on them. One day I saw, with the great black-backs, a large white gull which could have been no other than a glaucous gull, with which species I had been familiar in Spitsbergen. I suspect that this gull, when dead salmon are numerous, ascends the lower reaches of Highland rivers more often than is supposed. In the account of the gulls the difference in plumage between the British lesser black-backed gull and the Scandinavian lesser black-backed gull is clearly described (p. 96). In the Scandinavian species the mantle is slate-black ; in the British species slate-grey. During the years I had my home at Aviemore I used each spring to watch a migration of lesser black-backs flying, day after day, sometimes in considerable flocks, sometimes singly, north-east down the Spey valley. This migration continued through April and well into May, and the birds were presumably crossing from the Atlantic seaboard towards the Moray Firth basin, before travelling over the North Sea to the coast of Scandinavia.

A slight amendment might be made (p. 81) in the elevation at which the common gull is found nesting in Scotland. For "over 1,500 feet in Scotland" might be substituted "up to 3,000 feet". There is a loch on the White Mounth where a colony of these gulls nests at a height of 2,800 feet, and an occasional pair nests on a small loch higher up the hill, on the 3,000 feet contour line. These common gulls feed their young largely on ptarmigan eggs, which they steal from the nest and carry in their bills to their loch. The discarded egg-shells may be seen in the shallow water. This high loch is usually hidden in snow and ice in April, and the gulls pay several visits to it before they are able to settle here.

In the very full and thorough account of the Scottish ptarmigan (pp. 228—233) it is stated that the cock ptarmigan stands on guard when the young are hatched. The observer who makes this statement has great experience, but my own observations (I have seen many scores of ptarmigan nests and young broods) is that the male bird disappears from the nesting site the day the young leave the nest—and they leave it if the weather be fine an hour or two after they are hatched. My wife and I have photographed ptarmigan broods a few hours old, and although the hen has shown intense anxiety, the cock has never appeared. I mention this, for it has always seemed to me that the habit of a most devoted mate in suddenly deserting the newly hatched young is strange and unusual.

Ptarmigan, like red grouse, cover up their eggs before the clutch is complete and the hen bird begins to brood, and sometimes a few white feathers adhering to this covering give away the nest.

Ptarmigan are found in various forms throughout the world, and when I was in Iceland recently with Mr. J. C. Harrison (who has an admirable plate of skuas in flight in the volume under review) I was interested to see that the Iceland ptarmigan frequents the glens and low country, where it may be seen from the road. We both remarked that the wing beats of the Iceland ptarmigan were much more rapid than those of the Scottish ptarmigan, and that the flight recalled that of a partridge rather than a ptarmigan.

No one interested in birds can afford to be without the fifth volume of this standard work.

SETON GORDON.

THE MESSAGE OF THE GARDEN

Green Enchantment

The Magic Spell of Gardens. By Rosetta E. Clarkson. Pp. xx+328. (New York: The Macmillan Company, 1940.) 12*s*. 6*d*. net.

REALLY good enchantresses have always had more than one string to their bow, though those who escape their snares would probably put it the other way about. When they were young, enchantresses could afford to rely entirely on their charms for the bewitching of man ; but as they began to grow old and their charms began to fade, they took to casting spells. For that they had to go to the fields and hedgerows and gather green plants in the moonlight for the raw material out of which all the best spells are made. If enchantresses werel ucky and escaped a watery grave, their increasing years turned them into witches. Bent double by bending over ditches and riding broomsticks, they could no longer go far afield to find the herbs that specialized in being magical. That did not stop the witches, however, for they could find all the magic herbs they needed in the garden. From being used so often for spells, the plants grew more potent, and presently the garden itself became still more the home of magic than it had been before—a place of green enchantment.

No one can go into the garden now—be it large or small, wild or formal, neat or unkempt, well or ill planned—without falling under its spell ; at all events they will not after they have been taken there by Rosetta E. Clarkson and have heard the stories she has to tell of garden green enchantment.

How wise she is to begin with a sort of exorcizing to restore its good name to the garden. She says nothing at first about the witches and the spells and charms. She starts off with the gentle monks and their horticultural acolytes, and shows them at work in the monastery garden : planting herbs for healing, odorous plants near the sick room windows to appease the suffering inmates, lilies and roses and flowers of every kind in the sacristan's garden—these for the altar and for garlands in processions on holy days; they named it paradise. Even when urban popes and cardinals told them not to, the simple monks went on growing the flowers all the same. They made walled gardens for fruit trees and they made vineyards too. Is there not still a street corner called the Vineyard near the Abbey Gates at Abingdon ? Nor did the monks forget the vegetable garden. They planted it not only for summer use but also for food in the long winter.

Then when the monasteries declined, it was the wicked barons who took to gardening. They filled in their moats and made gardens there. They had to do something because Henry VII would not let them fight any more, nor use their castles as strongholds in his defiance.

Throughout these centuries plants from all over the world came crusading to England, and having conquered it settled down in our gardens. What the castle grew the cottager would have, and many a plant which died on the squire lived on in the cottager's plot. Why! it may be that to-day, Madonna lilies flourishing in a sunny corner of the cottage garden have been growing there since Tudor times : still magical in their immortality.

When printing came, everybody began to write about plants, and the great days of the herbalist began. Books by the score, editions by the dozen, sometimes by the hundred, were written and printed and even read.

All these things and many more are to be learned from Rosetta Clarkson's story. She shows you the plants they grew. Tells the lovely names the common people called plants by—no one except the very great was afraid of being called sentimental then. You can see the tools that were used. You can wonder at the infinite variety of sallets in the old gardens now dwindled to the solitary lettuce in ours, the flowers that went to conserves and preserves to give plenty of vitamin P on winter's table.

It is only towards the end of her story that the author opens a little wicket gate creaking on its hinges and leads her enchanted companions into the witches' garden ; lets you see the fumitory that wards off the evil eye, the rosemary for remembrance, the woodbine that has bewitched so many cattle, the elder that makes warts go away and the parsley with seeds that have to go nine times to the devil before they consent to germinate. Every witchery that ever was is still there, preserved for ever in the names the plants bear.

When she has finished and you awaken from the enchantment, there seems to come into the mind a new understanding of the ever green enchantment of gardens. There and there only may be got glimpses of the country—all the countries of the world—and of the forgotten ways of country life. There pleasure and utility go hand in hand, united, made one, so that for the moment life becomes a whole, as it never can be in cities. It beckons man back to Nature, and though urban folk ignore the invitation they feel the summons in their bones ; recognizing, if only faintly, that the problem facing all societies is how to remain urban without losing the last traces of rusticity. While there is life—garden life—there is hope, hope that the unspoken warning of the garden may be heeded before it is too late.

F. KEEBLE.

CHEMICAL ENGINEERING EXPERIMENTS

The Applications of Chemical Engineering

Edited by Prof. Harry McCormack, in association with E. W. Comings, J. C. Elgin, W. L. Faith, O. A. Hougen, Joseph H. Koffolt, Harry McCormack, R. A. Ragatz, J. H. Rushton, Henry T. Ward, J. C. Whitwell, James R. Withrow, Lincoln T. Work. Pp. x+431. (London : Chapman and Hall, Ltd., 1941.) 21*s*. net.

THE title of this work might indicate that it deals with the application of chemical engineering theories to the solution of industrial problems, but this is not the case. It is, actually, a comprehensive collection of experiments for the use of students. This, however, is an inadequate description ; the volume represents the outcome of the labours of a succession of committees which since 1929 have been collecting and arranging material suitable for a practical course, and the result is a detailed description of some seventy-five experiments classified under eleven main headings. Each heading forms a chapter written by an expert and revised by the committee in order to obtain uniformity of treatment. In a typical chapter the first pages are given up to a concise outline of the fundamental theories involved and the rest is devoted to the experiments, numerous specific references and a general bibliography of the subject being included.

It may be said that there are two main ways of presenting a practical exercise to a student. According to the first, he is given a piece of apparatus complete with all accessories and an instruction sheet detailing the object of the experiment and the exact method of performing it. According to the second, the object is given, but it is left to the student to think out what measurements must be made and what are the most suitable instruments to use. There is little doubt that the second method is of far more value for developing originality and self-reliance than the first, but unfortunately, it may require an excessive amount of time and more attention on the part of the instructor than can be given. A compromise depending on the ability and experience of the student is probably the best solution. His early experiments may be conducted according to instruction sheets to familiarize him with general experimental technique, but as he progresses, more and more details may be omitted, so that finally he becomes dependent on his own initiative. It has been found in Great Britain, more particularly with larger apparatus such as stills and evaporators, that instructions can be cut down to a mimimum provided that two or even three students are assigned to the same experiment so that they may make simultaneous measurements and also discuss problems which arise during their progress.

The experiments dealt with in the book, while in nature similar to those conducted in the larger chemical engineering laboratories in Great Britain, are described with a wealth of detail which makes possible the adoption of the first of the above methods should it be required. A drawing of suitable apparatus or plant is given and a list of measurements which can be made. This is followed by instructions for performing the experiment and a set of typical results, with complete calculations. Experimental details which might escape attention are emphasized and the underlying theoretical principles are referred to at frequent intervals.

With regard to individual chapters, the first, dealing with the measurement of temperature, is an admirable article on certain aspects of precision thermometry, including a few experiments reminiscent of the elementary physics laboratory, but it lacks reality, and its connexion with the practical requirements of chemical engineering is not always obvious. For example, a student reading the description of a platinum thermometer would have no idea of the size of wire with which it is wound, or its resistance. No reference is made to the errors due to thermocouple sheaths insufficiently immersed or to thermal conduction along thick pyrometer wires. Black-body errors are mentioned, but it is left to a later chapter to give an indication of their magnitude, while the measurement of the temperature of a gas is confined to a brief note on one type of thermocouple. In practice, electrical measurements are rarely made on simple slide-wire bridges, and students should learn how to operate special instruments from a study of the wiring diagrams ; the two examples given are not very clear. It is suggested that this chapter might be recast.

The following chapter dealing with the flow of fluids gives a number of useful assemblies of apparatus suitable for most requirements ; some of the diagrams are perhaps a little sketchy and there is less detail than is to be found in subsequent chapters, but the information given is adequate and a student who had conducted all the experiments would be well equipped for dealing with fluid flow measurements on industrial plant.

Some subjects lend themselves more readily than others to simple experimental investigation, and the flow of heat, a matter of outstanding importance to the chemical engineer and the subject of the next chapter, is fortunately one of the former. Professor McCormack's treatment is most lucid, and fundamental principles are repeatedly emphasized throughout the mass of experimental details. One point to which more attention might have been given, if only because it is frequently neglected by designers, is the great increase in liquid film coefficient obtained by the use of high liquid velocities. This chapter is perhaps the most outstanding in the book, but a similar high standard is maintained in the remaining eight, which are devoted to unit processes. If any of these can be specially commended they are those dealing with distillation, drying of solids and gas absorption. This is not so much for any special features but because they offer more scope for experimental treatment than the rest. Whether the equipment required belongs to the category "simple" as described in the preface, or not, is perhaps a matter of opinion, but there will certainly be general agreement that the practical side of chemical engineering cannot be studied without adequate plant. A second claim made in the preface is that every experiment can be accomplished in a single four-hour period. This may be correct, but the desirability of rushing through what is in some cases a fairly elaborate series of measurements following upon preliminary adjustments, is open to question.

For those who are contemplating the establishment of a chemical engineering laboratory the book will be found invaluable. The experiments described are so numerous and cover so wide a field that a judicious selection, modified to suit the available apparatus, should afford ample material for a useful course. Those who already possess a laboratory will find many suggestions, either for utilizing their existing equipment in novel ways, or for adding to it and thus extending the scope of their practical work. No text-book on these lines has been produced hitherto and the Society for the Promotion of Engineering Education is to be warmly congratulated for a very valuable contribution to chemical engineering.

H. E. WATSON.

GEOLOGY AND GEOLOGISTS IN THE NATIONAL WAR EFFORT

By PROF. H. H. READ, F.R.S.

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THERE appears to be considerable divergence of opinion among professional geologists in Great Britain as to the extent to which they and their knowledge can be used in war. Some hold that hundreds of geologists could be employed in the civil defence and armed forces; others protest that saturation would be reached by the employment of a score or so. Whatever may be the truth of this matter, however, all are agreed that the utilization of geological knowledge in the war effort has up to now been singularly haphazard. It is, of course, possible that a considerable proportion of the cases of the successful use of such knowledge never becomes public, while certain scandalous examples of neglect of geological information achieve, on account of their news value, a disproportionate notoriety. Still, if there were but one case of such neglect, the geologist would be entitled to lift up his voice. When he is officially informed that a sum approaching half a million pounds has been wasted through this cause at one aerodrome site alone, he must be pardoned if he becomes speechless, and especially so since, though he may faintly hope that those officials responsible for this waste have been liquidated, he is secretly sure that they have been promoted to posts with still greater possibilities.

As Prof. P. G. H. Boswell has pointed out in his presidential address to the Geological Society, issued on September 30, the fundamental reason for this haphazard utilization of geological knowledge is the lack of awareness on the part of the general public of the content of the science. The ignorance is, of course, especially profound among the politicians and the higher Civil Servants, while among scientific men it is often deplorable—a result in their case arising from a devotion, inculcated in the schools and fostered by examination requirements, to the unholy trinity of mathematics, physics and chemistry. One would have expected, on the grounds of value for money alone, a fuller utilization of geological knowledge which, in predominant proportion, has been accumulated and is being correlated and curated through the use of public funds of one kind or another. There is, however, little to be gained by elaborating this jeremiad, and we can with greater profit turn to the contemplation of such uses as have been made of geology and geologists in the war effort.

Large-scale industry, the sustainer of modern mechanical warfare, is founded upon iron ore and the solid and liquid natural fuels. Vital for the full development of its power, however, is a great variety of strategic mineral products, such as the alloy metals, the important non-ferrous metals, and a group of non-metallic minerals chiefly of a refractory or abrasive character. Further, food is a munition of war, and in consequence the mineral fertilizers are of strategic importance too. This fundamental dependence of industry upon mineral products becomes a lively topic during a time of mechanical warfare when it is impressed upon the political and Civil Service hierarchy that minerals are not evenly distributed among the nations, that supplies of vital raw materials are liable to interruption or even stoppage and that, in any event, minerals are bulky commodities usually requiring lengthy transport. A modern State, bent upon modern war, would naturally accumulate reserves of strategic minerals sufficient for the estimated duration of the conflict. We may be sure that the Axis has affected this obvious insurance, and that prophecies of an Axis shortage of oil, of some alloy metal or of some other strategic mineral product are liable to falsification.

An effort for autarky, or for the transformation of a peasant State into an industrial one, depends for success upon the discovery within the borders of the State of mineral resources of suitable size, character and variety. In this connexion, it may be recalled that thousands of geologists have been employed in mineral prospecting and development in the U.S.S.R. during the last twenty years. Their efforts have had remarkable successes; there have been notable and constant increases in Soviet mineral production, both in amount and variety. In NATURE of October 25, Prof. A. E. Fersman recorded that during the last quarter of a century, 75,000 new mineral fields were discovered in the U.S.S.R., that the known coal resources had been increased ten times, the resources of iron ore thirty-three times, and of lead and copper more than ten times. Fundamentally, therefore, the heroic Soviet resistance is possible because of the field-work of the Soviet geologists. It is my opinion that the most important use of British and American geologists in the war effort is to be found in the continuance of their jobs, often unheroic, of finding new mineral deposits and of developing maximum production of the required grades from these and the old fields. If the Allies hold on, it is comforting to reflect that the mineral resources of the British Empire, the U.S.S.R. and the United States are complementary to an extraordinary degree, while those of the Axis are thoroughly lopsided and, in the cases of the two junior partners, practically non-existent.

The interruption of supplies from overseas and the difficulties of transport have naturally led to renewed investigation, followed by development where possible, of native British mineral resources. In this work the dominant part is played by H.M. Geological Survey which, during its century of existence, has accumulated a vast store of information concerning mineral possibilities in Great Britain. The resources of coal and iron ore, the basic requirements of industry, have continued to be investigated in detail, while much attention has been directed to the discovery and workability of such ancillary metals and non-metallic minerals as this country can supply.

The results of a number of these investigations are given in the War-time Pamphlets issued by the Survey, which deal, in this connexion, with iron ores of various kinds, felspar, diatomite, dolomite and brucite-marble, silica-rock, phosphates, talc, chromite and limestones. This list, of course, by no means covers the complete field explored. It is gratifying to learn that production is taking place from mineral deposits discovered and investigated by the Survey. One success that may be mentioned is the find of a sand in Morvern, Scotland, suitable for optical glass and equal in quality to the best Continental sands, which is being worked on a considerable scale. In this type of investigation, the Survey is often helped by university and other geologists who have the advantage of detailed local knowledge. Such geologists, too, are being consulted on special problems of supply by Government and other bodies. In addition to investigations such as those mentioned, the

Survey deals with routine inquiries, some of which entail lengthy researches. A service of a similar nature dealing largely with inquiries from the Dominions, India and the Colonies is provided by the Mineral Resources Department of the Imperial Institute. This Department publishes monographs on economic minerals and valuable statistical reports on world mineral production.

The staff of the Geological Survey, however, is limited in number, its members rarely reside for long in any particular place, and they are unable, therefore, to record the innumerable temporary sections and exposures that are constantly being produced. The local geologist, whether university or lay, has opportunities of acquiring a detailed knowledge, especially of the superficial deposits, which is denied to his Government colleague. It is to the local geologist that the civil authorities, if necessary through the offices of the regional commissioner, should turn for geological information on such matters as the proper siting of shelters, supplies of sand, and questions of a kindred nature. So far as I am aware, this has been done in few cases; the results of this neglect can be seen all over the country. A similar absence of consultation between the military authorities and local geologists is indicated, for example, by the flooding of military works, the perilous position of certain tank blocks especially along rivers, and the instability of costly excavations. It is happier to record that in a few cases this desirable liaison has been established. Good work was done by some local geologists in indicating sources of sand for sandbag-filling in the early days of the War. Moreover, hundreds of thousands of pounds were saved in transport costs in London alone by following advice on the location of sand deposits given by the Geological Survey.

A very important war-time activity of the Geological Survey is connected with water supply, and many of the War-time Pamphlets deal with supplies from underground sources for various parts of the country. Movements of population, the formation of great military camps and aerodromes, and the construction of immense factories all raise problems in water-supply. Time was when a camp site was decided upon and then a water-supply demanded, but I understand that this procedure has now been changed. It is obvious that an accurate assessment of the present supply from underground sources, of emergency and even long-range supplies, has to be made, and especially in the so-called invasion areas. Piped supplies are liable to interruption by enemy action, and so the storage of water for fire-fighting in vulnerable districts may give rise to geological inquiry.

At the beginning of these remarks, I recalled the case of the scandalous neglect of geological advice at an aerodrome site, and I repeat that as complete a knowledge as possible of the geological conditions, both as regards water supply and foundation factors, at sites projected for costly camps, aerodromes and factories, is an obvious precaution. The Geological Survey and non-Government geologists are engaged in a certain amount of preventive work along these lines.

Readers of the more popular Press may have seen very remarkable accounts of some of the underground factories, stores and the like which have been constructed. Before the expenditure of vast sums of money on these great mining and engineering works, with their attendant housing and transport schemes, it is clearly a matter of common-sense to study in detail the prime control, the nature of the rocks and their arrangement. Here, again, the geologist has been utilized. The roughness of the geological story of Great Britain has resulted in our possessing a great number of suitable rocks suitably arranged for this purpose. A similar foresight is necessary in the construction of deep air-raid shelters and, again, most of our large towns have a fortunate geological past. At this point, non-geologists should ponder as to why London has its Underground, and draw a little comfort in these hard times.

What has been said above deals largely with the use, or non-use, of geological knowledge, but it has also been suggested that the best use of the geologist is to let him carry on with his usual work. This suggestion has not always been followed, and often it is the geologist himself who decides on a change of occupation. In certain branches of the Forces, a geological training is an advantage. All geologists can read maps and most can make them, some are expert drillers and others are familiar with mining and excavation methods. Men who have earned their living for years by the interpretation of aerial photographs should be employed in similar work in the Services. I have heard of an ex-geologist airman who finds his way about above England by his geological knowledge. There is a niche somewhere in camouflage for a geologist who will prevent the breaking of all geological rules in one small scheme, just as in happier times Hollywood might be persuaded to hire a geologist who would make sure that a film alleged to be in a Jerusalem setting would be set in Jerusalem geology, and not in that of California.

Such are some of the ways, then, in which geological knowledge and geologists are and are not being used in the war effort. The full employment of both can follow only from an adequate realization by the directorate of the possibilities of service.

MECHANISMS OF VISION

By PROF. SELIG HECHT

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THE symposium on visual mechanisms held on September 24 during the Fiftieth Anniversary Celebrations of the University of Chicago brought together some of the diverse methods and points of view found in the study of vision. Of the eight papers, three were concerned with the structures, materials and energy relations of the eye itself; one considered vision merely as an indicator of the state of the nervous system under anoxia; while the other four explored the relations between sensory phenomena and the central nervous system.

The morning session began with a report by Prof. Selig Hecht on the minimum energy required for vision. New determinations made under the best physical and physiological conditions yield values between $2\cdot2$ and $5\cdot7\times10^{-10}$ ergs, which correspond to 58 and 148 quanta of blue-green light (510 $m\mu$). This is at the cornea. After corrections for reflexion from the cornea, for scattering and absorption by the ocular media, and for transmission by the retina, the range of 58–148 quanta at the cornea becomes 5–14 quanta absorbed by the retina. Since the stimulated retinal area contains five hundred sensitive elements, a 2-quantum absorption by any one element is unlikely. Therefore, in order for us to see, only one light quantum need be absorbed by each of 5–14 retinal rods.

Because this number of events is so small, it may be derived from an independent statistical study of the relation between the intensity of a light flash and the frequency with which it is seen. Such experiments yield values of 5–7 for the number of critical events involved in threshold vision. Biological variation does not alter these values essentially, and the agreement between directly determined values and those derived from statistical considerations may be considered significant.

The results bear on the nature of the fluctuations shown by an organism in its response to a stimulus. The assumption has generally been that the stimulus is constant and the organism variable. The present considerations, however, show that at the threshold it is the stimulus which is variable and that the nature of its variability determines the fluctuations encountered between response and stimulus.

The light-sensitive substance of the retinal rods is visual purple. Prof. Arlington C. Krause, of the University of Chicago, has prepared enough visual purple so that common chemical procedures may be used for its study. He reported that visual purple consists of 50–65 per cent protein and 35–50 per cent lipid. The protein, though not well characterized, is conjugated with a complex lipid of fairly large molecular weight. The lipid contains nitrogen, sulphur and phosphorus fatty acids, and an unsaturated chromophore group, which may be carotenoid but is probably neither vitamin A nor carotene.

Several new substances can be isolated from the retina. Provisual red absorbs light between 340 and 416 mμ, gives an antimony trichloride reaction, and on hydrolysis yields fatty acids and visual red. Visual red absorbs only in the violet and ultra-violet, and also gives an antimony trichloride reaction. The yellow colour of bleached visual purple is due to visual yellow and indicator yellow. Visual yellow contains no nitrogen, phosphorus, or sulphur, and is insoluble in water. Indicator yellow contains both nitrogen and phosphorus, and is water-soluble.

Prof. Krause emphasized the similarities in light sensitivity and structure shown by visual purple and by cyanine dyes used for sensitizing photographic emulsions.

One of the outstanding characteristics of the central nervous system is its high metabolism and its great sensitivity to the lowering of the oxygen tension of the blood. Since visual impulses ultimately register in the central nervous system, visual function should be disturbed under anoxia. Prof. Ernst Gellhorn, of the University of Illinois, reported just such changes in brightness discrimination, visual acuity, colour perception, visual fields and negative after-images, and emphasized the rapid reversal of the effects by inhalation of oxygen. Since all these effects have in common the sensitivity of the nervous system to anoxia, it is concluded that they are an expression of this common factor. (It should be recalled that the retina also has a high metabolism and is sensitive to oxygen; indeed the recent work of Craik shows that visual function may be disturbed by local anoxia at the eye.)

Prof. Gellhorn presented evidence to show that the central nervous system possesses a progressively increasing sensitivity to anoxia in proportion as one goes to higher levels. This is illustrated by the effect of anoxia on eye movements: those which are elicited reflexly are less affected by anoxia than those which are cortically determined.

The final morning paper was by Prof. Heinrich Klüver, of the University of Chicago, who summarized the difficult and beautiful experiments with Rhesus monkeys made before and after removal of the striate cortex. By use of the pull-in technique, it was possible to measure the visual capacities of such animals in considerable detail. The results show striking differences between operated animals in dim illumination and in bright illumination. Dark-adapted animals without any geniculo-striate system are still able to discriminate the brighter of two stimuli under a variety of modes of presentation of the two stimuli. The just recognizable brightness fraction $\Delta I/I$ lies between 0·23 and 0·29. The same differential fraction is obtained for area discrimination of equally bright surfaces, and for distances (squared) of otherwise equal fields. This indicates that it is the total luminous flux which is recognized, rather than its distribution in space. A difference in total amount of light is distinguished whether it is achieved by distance or by area or by brightness variation. Form perception is thus permanently lost.

All this is at low illumination and involves only the dim vision of the duplicity theory. Indeed the effectiveness of the spectrum bears this out, because it yields a luminosity function similar to the scotopic luminosity curve of the human eye. For higher illuminations involving light adaptation, the operated animals lose all trace of differential response.

In the normal monkey, recognition of differences in brightness or area or colour are not seriously affected by the way in which the stimuli are presented. It is as if these properties remain relatively constant despite marked changes in stimulus constellation, and thus provide the animal with a stable visual world. The removal of the geniculo-striate system seems to eliminate these constancies irretrievably.

The afternoon session was opened by Prof. Theodore J. Case, of the University of Chicago, with a paper on occipital alpha waves. Under normal conditions, these rhythmic brain potentials from the two sides are in phase and approximately equal. Occasionally persons appear in whom there exists a gross difference in size of the occipital waves from the two sides, whereas the frontal alpha waves are equal. Such individuals possess lesions in the occipital or temporal lobes, usually involving the optic radiations that pass through these structures, and therefore causing partial blindness (homonymous hemianopsia) on the side opposite the lesion.

Examination of more than a hundred persons with supratentorial lesions showed that whenever the optic radiations were involved, there was always a substantial difference between the occipital alpha waves on the two sides, so much so that a gross difference in occipital waves may be considered almost a diagnostic sign of occipital or temporal lobe lesions. Since an interruption anywhere in the geniculo-calcarine pathway interferes with the occipital alpha waves of that side, and at the same time destroys vision, it may well be that the alpha waves actually exist in the optical radiations as an intrinsic rhythm upon which impulses from the visual organ impinge to form patterns for the mediation of vision.

Following this paper, Dr. S. Howard Bartley, of Washington University, presented some correlations between vision and neurophysiology. First, he compared the potential changes in the optic nerve on stimulation of the eye with the known corresponding sensory experience. A short, weak flash of light results in a simple optic nerve discharge without subsequent changes. In vision this is registered as a simple flash of light. With a longer or more intense flash, the optic nerve record is a series of fairly regular waves following the simple *on* response. Visual experience reports this as a brief period of just distinguishable flicker. With a still longer or a more intense flash, there appears a prominent secondary wave which replaces the train producing the flicker; it and the *on* response yield the paradoxical experience of seeing two flashes. The secondary wave drops out as intensity or duration is increased, and visual experience loses its duality.

When the cortical response is recorded, the results are not so clear, and frequently involve interpretation. The most interesting fact is that a strong repeated stimulus may force the cortex to set up a rhythm in tune with the stimulus.

The paper by Prof. Stephen Polyak, of the University of Chicago, was a brief summary of material since published as a volume, "The Retina", in the Anniversary Series of the Chicago University Press. The essential point is that the complex structure of the retina agrees with the complex nature of the visual process. There are at least thirteen different types of neurons in the retina arranged in three levels: the photoreceptors (rods and cones), the analysers and association neurons (bipolar cells, horizontal cells and probably amacrine cells), and the integrators (ganglion cells).

The relations among these elements are complex and stable, and are at least thirty-five in kind. Some indicate an analysis of impulses from the photoreceptors; others suggest 'final common path' functions; while still others may even be inhibitory. Besides the perception of light and of colours, the retinal structures lend themselves to an interpretation of the various aspects of space perception, in terms of the degree of individuality in the connexions of the three components.

The symposium was closed by Prof. K. S. Lashley, of Harvard University, who proposed a new theory of cerebral organization. Animals are capable of perceptual generalization. When trained to differentiate on the basis, say, of specific sizes, they carry this over to a variety of visual arrangements. An object retains its essential form though we view it from different fixation points. The problem is that while nerve impulses are transmitted over definite pathways, behaviour seems to be determined by masses of excitation within general fields of activity without regard to particular nerve cells.

The exact topographical projection of the retina on the striate area may not be primary, because the olfactory sense is also accurately projected, yet it does not correspond to olfactory space. It may be that the geometry of nervous integration is quite different from the geometry of the stimulus.

The surface of the cortex contains connexions which permit the passage of activity in all directions. From a single focus, excitation may spread over the whole cortex, and because of the refractory period this spread will be wave-like. From several foci, interference patterns will be formed extending over the whole cortical area. Thus a given retinal configuration can produce a characteristic pattern of standing waves on the cortex which then forms the basis for its recognition.

Motor responses also are generalized. A rat which has learned a maze can follow it with unpractised muscle groups; thus a rat with a cerebellum lesion will roll rather than crawl through the maze successfully. The essential equivalent of visual perception is thus translated into an essential equivalent of muscle function. This means a revision of current notions of sensory motor organization. There is demanded a much more diffuse and widespread connexion between sense organ and motor neurons, a connexion in terms of an overall pattern perhaps such as is suggested for sensory organization.

RECONSTRUCTION IN CHINA

By ZING YANG KUO

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CHINA has already begun to plan her national reconstruction after the War. But given good plans for Chinese reconstruction, and given sufficient capital and raw materials, China may not be able to carry out her programme of reconstruction successfully and effectively unless she has adequate supply of scientific men, engineers and technicians. At present there is already great shortage of trained personnel in various fields, especially in science and technology. Due to the lack of library and laboratory facilities as a result of destruction by the Japanese, and also to the insufficient number of first-grade professors in China, the training of scientific and technical personnel for cultural and economic reconstruction in China will depend, more than ever before, upon sending students to study in American and British universities. Unfortunately, since the outbreak of the war in China, the number of students studying in the United States and Britain has been reduced by more than a half, while very few remain on the European Continent. Unless a well-planned programme for training men and women for the tasks of reconstruction is worked out well in advance, the shortage of scientific and technical personnel will be very much more acute when the War ends and reconstruction in industry and agriculture is begun.

Such a programme for training scientific and technical personnel for China calls for the active co-operation and assistance of Great Britain and the United States. It means that for many years to come, before the Chinese universities are re-equipped and brought up to modern standards, and have sufficient good teaching staff, Chinese students will continue to be sent by hundreds to the United States and Britain for scientific and technical education; it means that many American and British professors will have to be invited to teach in Chinese universities.

It was with this purpose in mind that I am visiting Great Britain and the United States as the representative on education of the Chinese Government to seek for co-operation and assistance from these two countries. As the project of inviting visiting professors to teach in Chinese universities cannot be carried out before the universities are sufficiently re-equipped, my negotiations in Great Britain have been confined to the arrangements for sending Chinese students to study in British universities or to obtain experience in factories. There are two parts in this project: (1) sending graduate students with two or three years of practical experience in China, either to study in a British university or to practise in a British factory; and (2) sending a number of Chinese university teachers, especially teachers of science and technology, to Great Britain, to refresh their learning and to get acquainted with the latest developments in various scientific and technical fields.

British intellectual and industrial leaders have responded sympathetically and generously to my proposal in connexion with the first part of the project. If the arrangements so far made for sending Chinese students to be trained in Great Britain are carried out with success, I shall, in the near future, take up negotiations concerning the second part of the project.

American educational and industrial leaders have also responded to my proposal with sympathy and enthusiasm. It is hoped that through exchange of information and mutual understanding, the efforts of Great Britain and the United States to assist China to rebuild her culture and to train young minds for her national reconstruction can be coördinated, and that greater cultural co-operation between China and the English-speaking nations can be secured.

I have laid great stress on the importance for the national reconstruction of China after the War of training scientific and technical personnel. This must not be taken, however, to mean that other aspects of cultural studies, such as fine arts, philosophy, literature and the humanities, etc., are to be neglected. On the contrary, such subjects will receive due attention in the programme of cultural reconstruction in China. In fact, it is my hope that even in training young scientific workers and engineers each student would acquire a good cultural background together with his technical education.

OBITUARIES

Viscount D'Abernon, P.C., G.C.B., G.C.M.G., F.R.S.

EVEN in peace-time, there is a constant but subdued lamentation on the part of scientific men that their subject receives but scant consideration by politicians and others controlling public affairs in formulating and executing public policy. In war-time such lamentation is less subdued. When, therefore, a great public figure has used the weapon offered by science to the great benefit of the State, it is only right that his death should call for more than a passing reference. Viscount d'Abernon, whose death at the age of eighty-four occurred on November 1, was a man who, without any special training in science, came to have a great belief in the part it might play in government. He was a man of remarkably wide interests and achievements, a statesman but not a politician, and a man of the highest culture, who knew, or wished to know, the best that had been thought and said in the world. He had also the keenest appreciation of art, especially of painting and the drama. Nothing human was foreign to him.

It will be remembered that, in the War of 1914–18, alcoholic intoxication became an enormous problem, of such magnitude indeed that it interfered greatly with the production of war material. To meet this situation, Mr. Lloyd George set up the Central Liquor Control Board and made Lord d'Abernon its chairman. The object was to find any or every means, short of prohibiting the production and sale of alcoholic liquor, which could reduce the evil to a minimum. The success obtained by this Board has never been really appreciated, but those who remember the extent of drunkenness in pre-war days cannot but conclude that the Liquor Control Board conferred one of the greatest social blessings on Great Britain. This inappreciation of valuable work is often seen when the state of man is changed for the better. Most medical men are very familiar with the phenomenon. They know only too well that, when a dramatic method of treatment is discovered, so that the dying or moribund are restored to health, this and its discoverer are hailed with great enthusiasm. They know equally well that, when a disease is eliminated by the discovery and application of a preventive method, there is no excitement, the change passes unnoticed and is taken for granted. This is what happened as the result of Lord d'Abernon's work in the case of alcoholic intoxication. The country has become relatively sober and the accursed social conditions due to widespread drunkenness have practically disappeared without comment.

Those with intimate knowledge of the Liquor Control Board know that Lord d'Abernon was not a figure-head as its chairman, but that he played the leading part in its deliberations and activities and gave up all his time to its work. The masterly way in which he controlled a body, which included brewers, clergy, politicians and Civil Servants, and obtained from them unanimous decisions, was a remarkable achievement. Confronted as he was at all stages by partisan statements on the action of alcohol, he decided that the only way of getting the truth was to appoint a body of scientific men in an advisory capacity. This body included among others Prof. (now Sir Charles) Sherrington, the late Prof. A. R. Cushny, Dr. (now Sir Henry) Dale, the late Prof. W. McDougall, and Prof. M. Greenwood. They gave careful consideration to the whole question of the pharmacology and toxicology of alcohol and proceeded to write the well-known book "Alcohol: its Action on the Human Organism". Where there were outstanding gaps of practical importance in knowledge, such as the relative intoxicating properties of concentrated and dilute alcoholic beverages, or the rate at which alcohol disappears from the body, or the kind of food which best inhibits or reduces the intoxicating effect of alcohol, he called for further experimental work. It fell to my lot to carry out this work on behalf of the Central Liquor Control Board. It was characteristic of Lord d'Abernon that he was not content simply to receive the results of this work, but often went to see the experiments on animals and man being made.

Had the Central Liquor Control Board been allowed to continue its work, d'Abernon's success in settling the liquor problem would have been even greater than it was. As soon, however, as Mr. Lloyd George saw that parliamentary agreement could be obtained on some of the Board's recommendations, he jumped in, secured the necessary legislation and dismissed the Board. Even so, its success was enormous, so that in a broadcast in 1931, Lord d'Abernon was able to say that "it had directly or indirectly added 100 millions to the public revenue and had cured the country of nearly two thirds of the evil results of intemperance". Brewers and distillers and public houses continued their lucrative trade, shareholders in these concerns drew the same or larger dividends. Patrons of Bacchus could still get their quota of drinks, although more dilute than formerly, at more restricted hours and greater cost. Most of those directly interested in the trade were happy, and the rest of the country saw less home misery and fewer drunkards in the streets.

It is impossible in this place to write about other activities of Lord d'Abernon, but any one man who could be chairman of the Betting Control Board, of the Medical Research Council, the Industrial Health Research Board, the Lawn Tennis Association, the Thoroughbred Horse Breeders' Association, a trustee of the Tate and the National Galleries, clearly had many attributes of greatness. In the public eye, the most outstanding post held by Lord d'Abernon was his appointment in 1920 as the first British Ambassador to the German Republic, a position he held until 1926. Here again it is impossible to write of his work, but it is no secret that his ambassadorship was very successful and that in the eyes of those Germans who were in a position to know, he was regarded in Germany for several years as its uncrowned king. There was real friendship and trust between d'Abernon and Stresemann in those days, and the death of Stresemann at a crucial moment in international negotiations was always regarded by d'Abernon as one of the major calamities of Anglo-German relations.

After returning from Berlin, d'Abernon wrote a statistical report about conditions in Germany, which aroused great interest, and one result of this was his election to the presidency of the Royal Statistical Society. He was also made chairman of the Royal Commission on Museums and Galleries, and in this capacity rendered substantial services to science. In 1931 he was elected chairman of the Medical Research Council, but, shortly after his appointment, he unfortunately developed the first signs of the illness which incapacitated him, so that for the last five or six years of his life he was unable to participate in public life. It may be said, however, that during the early period of his chairmanship of the Medical Research Council, he broke all precedent by insisting on knowing personally individual workers of the Council, and on discussing with them their problems under investigation. Some of the friendships he formed with scientific men he retained to his death, and he never lost interest in their subject. His belief in the power of science to supply facts and knowledge necessary for the efficiency of the State was implicit, and towards the end of his life he wrote: "given persevering research and the proper use of available knowledge, we can confidently hope that within a generation every individual might be allowed to have the full development of health belonging to his inborn potentiality." Had we a few more men of affairs who, in addition to paying lip service to scientific methods and results, had the same belief in science and the prepared mind to make use of it, Great Britain would be a better place in which to live.

In 1934 Lord d'Abernon was elected to the fellowship of the Royal Society, a distinction he greatly prized.

EDWARD MELLANBY.

Mr. T. E. Barr Smith

By the death of Tom Elder Barr Smith which was recently announced by cable, South Australia has lost one of the best of her citizens and the University of Adelaide a good counsellor and generous friend.

T. E. Barr Smith received his school education at St. Peter's College, Adelaide, whence he proceeded to Trinity Hall, Cambridge. He was the senior member of the firm of Elder Smith & Co., shipowners and wool merchants of Adelaide, with large pastoral interests in South Australia. Being intimately acquainted with both the production and marketing of wool, alive to the bearings of scientific research on the former and trusted by everyone, he played a useful part in the development of Australia's primary industry along sound lines.

Education and culture in South Australia owe much to the public spirit and generosity of members of the firm of Elder Smith & Co. When the University of Adelaide was founded in 1874, Sir Thomas Elder provided one half of the cash endowment, and Robert Barr Smith, Tom's father, endowed the library. Some twenty years later, Sir Thomas Elder presented a further handsome sum to found and endow a chair of music and a Conservatorium. Another partner, Peter Waite, left his fortune to endow a chair of agriculture and a research institute as part of the Department of Agriculture. The Waite Institute at Glen Osmond on the outskirts of the city is well equipped and provided for, and one of the most flourishing research institutes in the British Commonwealth. Yet another member of the firm of Elder Smith, Walter Young, served for many years as treasurer, and the University owes much to his wise guidance, particularly during the difficult years of the world economic crisis at the beginning of last decade, when the financial stability of Australia was shaken.

Tom Barr Smith's gifts to the University of Adelaide were generous and frequent. A vigorous young University must continuously expand its activities, and he contributed handsomely towards many of its developments. His largest single gift was a new home for the library. The Barr Smith Library is a fine separate building with ample provision for expansion. It is convenient, comfortable and comely. It serves as a noble monument to keep green the memory of one of the best friends of the University in the minds of future generations of alumni.

Tom Barr Smith was genuinely interested in science and learning, and found enjoyment in the companionship of those with similar tastes. Many scientific visitors to Australia will remember the charming hospitality extended to them by Mr. and Mrs. Barr Smith at their home at the foot of the Adelaide Hills, and their enjoyment of the company of this kindly, modest and shrewd Australian.

CHARLES MARTIN.

WE regret to announce the following deaths:

Prof. P. Flemming, emeritus professor of ophthalmic medicine and surgery in University College, London, known also for his work in archæology, on December 19.

Capt. T. A. Joyce, O.B.E., formerly deputy keeper in charge of the Sub-Department of Ethnography, British Museum, on January 3, aged sixty-three.

Prof. S. M. G. Ure, assistant professor of chemical engineering in the Imperial College of Science and Engineering, and reader in the University of London, on December 25.

Prof. T. Henry Wilson, formerly King's professor of midwifery in Trinity College, Dublin, and president of the Royal College of Physicians of Ireland during 1926–27, on November 20, aged seventy-eight.

NEWS and VIEWS

The Washington International Pact

WHEN the history of the present times comes to be considered by a future generation, it is probable that the joint declaration signed at Washington on January 1, by the countries arrayed against one or more of the Axis powers, will mark a significant phase in the history of the world. By this document, no fewer than twenty-six nations have voluntarily subscribed to the fundamental principles of the Atlantic Charter signed by President Roosevelt and Mr. Winston Churchill last August. They have asserted their belief in the sanctity of human life, liberty and independence, and the preservation of human rights, justice and religious freedom in all lands. Further, the declaration is open to be adhered to by any other nations contributing to the struggle against the militarism, aggression and oppression represented by Nazism. By this momentous step, the freedom-loving nations have banded themselves together against a common enemy, and little imagination is required to see in it the beginning of the international collaboration which must follow the War if the world is not to be subjected to further upheavals with all the horrors of modern warfare. The free association of nations in the task of ridding the world of Nazi tyranny, and from the medieval suppression of learning and of freedom of thought which have characterized its progress through Europe, is a necessary preliminary to the building of that better 'order' towards which the thoughts of men are turned.

New Year Honours

THE following names of scientific men and others associated with scientific work appeared in the list of New Year Honours :

G.C.B. : Sir Frank Smith, controller of telecommunications equipment, for services to the Ministry of Aircraft Production and to the Ministry of Supply.

Knights : F. C. Cook, chief engineer, Highways, Ministry of War Transport ; Col. J. R. Davidson, lately chief engineer, Metropolitan Water Board ; A. H. R. Fedder, chief engineer, Bristol Aeroplane Co., Ltd. ; H. M. Glover, chief conservator of forests, Punjab ; Prof. Bennett Melvill Jones, professor of aeronautical engineering, Cambridge, for services to aircraft development ; Dr. Cattamanchi R. Reddy, vice-chancellor of Andhra University ; Rao Bahadur Tiruvadi S. Venkataraman, sugar-cane expert, Coimbatore.

C.B. : Col. E. Gold, deputy director, Meteorological Office.

C.M.G. : Major G. St. J. O. Browne, labour adviser to the Secretary for the Colonies ; Prof. H. C. Sinderson, professor of medicine, Royal College of Medicine, Iraq ; A. J. Wakefield, inspector-general of agriculture for the West Indies.

C.I.E. : Sri Krishna, Forest Research Institute, Dehra Dun ; J. C. McDougall, Indian Agricultural Service, Central Provinces and Berar ; J. W. Nicholson, conservator of forests, Orissa.

C.B.E. : Dr. G. C. Anderson, secretary, British Medical Association ; J. M. Crofts, lately secretary, Northern Universities Joint Matriculation Board ; Miss M. Curtis, principal assistant secretary, War Damage Commission, principal designate of Newnam College, Cambridge ; A. C. Inskip, adviser to the Government of India on tanning and leather ndustries ; W. A. Macpherson Walker, adviser to the Government of India on jute supplies ; F. J. Martin, director of agriculture, Sierra Leone ; E. C. Ramsbottom, director of statistics, Ministry of Labour and National Service ; A. P. Rowe, superintendent, Telecommunication Experimental Establishment, Ministry of Aircraft Production ; Prof. S. P. Smith, professor of electrical engineering, Royal Technical College, Glasgow ; A. Wilson, a director of Imperial Chemical Industries (Explosives) Ltd., for services to the Ministry of Supply ; J. F. Wolfenden, lately director of pre-entry training, Air Ministry, headmaster of Uppingham.

O.B.E. : W. Abbott, staff inspector of engineering, Board of Education ; N. Barraclough, deputy chief inspector of mines, India ; W. R. Benzies, superintendent of natives, Bulawayo ; P. H. Carpenter, director, Scientific Department, India Tea Association, Tocklai, Assam ; E. L. P. Foster, chief forest officer, Andamans ; J. H. N. Hobday, chief veterinary officer, Bechuanaland ; G. Mayne Hopkins, divisional forest officer, United Provinces, India ; P. I. Kitchin, principal of Rugby College of Technology and Arts ; G. H. McKenzie, assistant production manager, Imperial Chemical Industries (Explosives) Ltd. ; H. E. Page, superintendent, Cordite Factory, Aravankadu ; P. E. Pollard, principal scientific officer, Air Defence Research and Development Establishment, Ministry of Supply ; N. S. Stevenson, conservator of forests, British Honduras ; J. Thompson, chief inspector of fisheries ; Dr. A. B. Wood, superintending scientist, Mine Design Department, Admiralty.

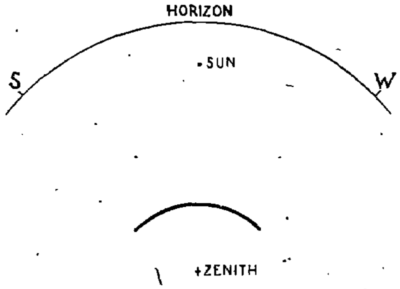
M.B.E. : P. W. Augier, divisional forest officer, Bihar ; J. McC. Black, a prominent botanist in South Australia ; W. E. Butler, factory works manager, Imperial Chemical Industries (Explosives), Ltd. ; J. A. Crosbie, mechanical engineer, Sind ; A. V. Gibberd, agricultural officer, Nigeria ; M. J. McDonald, divisional forest officer, Gorakhpur, United Provinces ; N. P. Mohan, deputy conservator of forests, Punjab ; Miss C. Murray, lately superintendent of domestic science, Glasgow Education Authority ; N. R. Reid, veterinary officer, Tanganyika ; B. N. Sarkar, deputy director of agriculture, Bihar ; J. T. Stapleton, technical officer, Directorate of Technical Production, Ministry of Aircraft Production ; G. V. Trivedi, divisional forest officer, Balaghat, Central Provinces, India ; Major O. H. Wansbrough-Jones, R.E.

University of Sheffield

THE thirty-sixth annual report of the Senate to the Court of Governors of the University of Sheffield for the year ending July 31, 1941, shows that the University had an active year in which academic and national interests had to be nicely balanced. During the year, the Departments of Zoology, Botany and Geography moved into the extensions at Western Bank in preparation for the 1941–42 session, thus releasing much-needed accommodation for the medical sciences and mathematics, and for the library. Fortunately, although no University building escaped damage during heavy air raids, there was little interference with work. The number of full-time students, which was 767 in 1938–39, fell to 667, but it is stated that the figures for the current session show no further decline ; only about a quarter of the students submitted themselves for voluntary medical examination at the beginning of the session. The Department of Engineering was engaged for some time with day and night training of semi-skilled mechanics for armament factories, thus anticipating the Ministry of Labour scheme, and has since turned to the production of munition components. Many members of the staffs of the Departments of the Faculties of Pure Science, Medicine, Engineering and Metallurgy, have carried on research work in connexion with the war effort in addition to their normal duties. The Regional Committee for Education in H.M. Forces, centred in and worked from the University, arranged 702 lectures and talks.

A Brilliant Atmospheric Arc

OPTICAL phenomena appear to have been very prominent in the upper atmosphere over the south-east of England on November 9, 1941. An account of a brilliantly coloured arc has been received from Mr. A. F. Dufton, of the King's Lodge, Hunton Bridge, Herts. Although the colouring is described as fully as brilliant as that of a rainbow, the colours being in the usual sequence with the red outermost, the accompanying sketch, which was sent by Mr. Dufton, shows that the arc was not part of an ordinary rainbow, being parallel with the horizon. The radius of curvature was estimated to subtend about 40°, the sun being estimated to be about 50° from the nearest point of the arc (the middle of the arc). The phenomenon was seen at 4 p.m. B.S.T., and a trace of cirrus cloud was present. On the same day, Mr. L. C. H. Cave, of the Old Rectory, Blechingley, Surrey, as reported in *The Times* of November 24, that he saw a mock sun at Hitchin of exceptional brilliance, also at 4 p.m. B.S.T. This is described as being so bright that it was almost difficult to look directly at it.



West African Forestry during 1940

IT may be asked whether the constant reiteration of the forest policy envisaged for the several Colonies under the Colonial Office produces the results obviously aimed at by the writers of annual forestry reports. The administrative authorities pass these reports and doubtless think that these statements read well and do not commit them to anything; and results in the past have shown this to be true. A forest policy put up by the forestry adviser may be accepted in whole or in part, but ruthlessly countermanded in a few months time for reasons having no connexion with a true appreciation of the value of the forests in the interests of the community. The heads of all three forest services in West Africa, Nigeria, the Gold Coast and Sierra Leone comment in their annual reports on the absence of military duties of a high percentage of their gazetted officers. The Conservator in Sierra Leone has four assistants; yet between them they only put in 18 months work in the department during the year (1940). At the end of the same year twelve officers, about half the Gold Coast forest staff, were on military service; while in Nigeria more than one third of the gazetted staff were on military service or other war-time duties. Yet in each Colony war-time demands are accelerating the exploitation of the forests. It is not therefore surprising that much of the work of a trained forest officer in the introduction of a proper management, such as reservation, including stock mapping preceding exploitation, in sylvicultural work with the object of the perpetuation of the forest estate, and other professional development work, was almost in abeyance during the year in all three Colonies.

It is difficult to regard this position with satisfaction in view of the recent debates in both Houses of Parliament on Colonial matters. For in each the inference was that the Colonial Office is not awaiting the end of the War, but is even now busy considering how the administrative machinery may be best speeded up and shaped so as to enable better conditions of livelihood to be enjoyed by the populations in the future. Where the improvement of agricultural practices is in question, or even education, the results —mistakes or otherwise—may become apparent within a few years. This is not the case with forestry. The postponement and procrastination displayed in the acceptance and adoption of a correct forest policy is almost a commonplace when applied to many of the Colonies; as is a recognition that forests cannot remain in a balancing or stable condition. They are either constantly improving or degrading. The most serious result of the absence of so many officers from the forest departments is the further delay in speeding up the placing of forest areas into the category of reserves when they come under the direct management and care of the forest officer.

Public Health in the United States

ACCORDING to provisional data for 1939 compiled by the Public Health Service of the United State the general mortality in 45 States, the Districts o Columbia, Hawaii and Alaska, was 10·7 per 1,000 inhabitants, as compared with 10·6 in 1938. Infantil mortality was 48 per 1,000 living births, the lowest hitherto recorded. The fall in maternal mortalit continued, being 10 per cent lower than in 193 (4 per cent live births). During the year 1939 n case of cholera or yellow fever was reported, but on case of plague was notified in the State of Utah There were 403,037 cases of measles, or less tha half the number in 1938, and 9,877 cases of smallpox as compared with 14,938 in the previous year At the beginning of the summer of 1939 there was a outbreak of poliomyelitis in the States of the Atlanti coast with a total of 7,339 cases compared with 1,70 in 1938. The incidence of diphtheria, cerebrospina fever, scarlet fever, typhoid and paratyphoid fever was much less than the average for the quinquenniu 1934–38. There was an outbreak of influenza i February 1939 which subsided towards the midd of July, but there was another outbreak in Octobe which lasted until June 1940; in 1939 there wer 275,503 cases notified, or more than double those i 1938 and 40 per cent above the average for th quinquennium 1934–38. 2,996 cases of typhoid fev were notified in 1939 as compared with 2,294 i 1938. The mortality from typhoid, paratypho measles, scarlet fever, diphtheria, encephalitis, meningitis, tuberculosis, malaria, pellagra, affections of t alimentary tract, syphilis, diarrhœa and enteritis in children under two years, and accidents (including motor accidents) were the lowest reported in the last five years. The mortality from pneumonia was very low in 1939, the diminution being more than 33 per cent compared with 1938. The increases in the mortality from cancer, diabetes, cerebral hæmorrhage and heart disease must be attributed principally to the greater age of the population.

Nature of the Long-period Variable Stars

R. M. Scott has an article on the long-period variable stars in the *Telescope* of September–October, which provides a popular description of the type of star of which Mira is a prototype. The spectra of these stars reveal that they are cold enough to contain molecules, and yet sufficiently hot to show the bright lines of hydrogen and ionized metals, and a brief explanation of the probable reason for this follows. Assuming that these stars are pulsating, we can picture a small core about the size of our sun surrounded by an atmosphere extending to a distance comparable with that of the earth from the sun. Viewed from a distance, one of these stars would present the appearance of a luminous fuzzy ball, deep in a hazy murk, and it is easy to imagine flames similar to solar prominences hovering deep in the smoky atmosphere near the luminous core. Then as the star approaches minimum the atmosphere would become darker and more clouded and the core a deeper red, the eruptions practically disappearing. It is possible that these red variables may be a link in the evolutionary chain, great numbers of stars starting their lives as red variables and then outgrowing their adolescent pulsations. On the other hand, red-variable pulsations may represent the palsy of stellar old age, though the former theory is the more popular of the two. At present this type of star presents a problem which can only be solved by much more investigation.

William James (1842–1910)

William James, the well-known psychologist and philosopher, was born in New York on January 11, 1842, the son of the Swedenborgian theologian Henry James and brother of the novelist Henry James. He studied medicine at Harvard, where he qualified in 1869. He never engaged in practice, but after occupying the chairs of anatomy and physiology at Harvard he devoted himself entirely to psychology and philosophy. From 1889 until 1897 he was professor of psychology and from 1897 until 1907 professor of philosophy at his *alma mater*. During his last years he was chiefly occupied by the study of religion and metaphysics. He is perhaps best known for his championship of the doctrine of pragmatism inaugurated by C. S. Peirce of Cambridge, Massachussets, according to which the value of any assertion is tested by its practical bearing upon human interests and purposes. He died on August 27, 1910. His principal publications were "Principles of Psychology" (1890), "Talks to Teachers on Psychology (1899), "Varieties of Religious Experience" (1902), and "Pragmatism" (1907). Numerous honours were conferred upon him at home and abroad, including membership of the National Academies of America, France, Italy, Prussia and Denmark, doctorate of letters at Padua and Durham, doctorate of laws at Harvard, Princeton and Edinburgh, and doctorate of science at Oxford and Geneva.

Association of Special Libraries and Information Bureaux

The sixteenth annual general meeting of the Association of Special Libraries and Information Bureaux was held on December 13, 1941. The chair was taken by the president, Sir Harry Lindsay, director of the Imperial Institute, whose introductory remarks touched on the widening scope of the Association's activities, a subject that was further developed by Mr. E. J. Carter, the honorary secretary, in his review of the year's work. The Association was fortunate enough to come through the winter's air-raids with only minor damage to the office; membership has remained steady and publications continued as usual. New opportunities for service arising from war conditions have been seized, among which was the investigation into the location and supply of scientific and technical periodicals now reaching the country from enemy and enemy-occupied territories, a survey carried out under the auspices of the Royal Society and the Rockefeller Foundation. Further details of the information thus compiled can be obtained on application to the ASLIB Office at 31, Museum Street, London, W.C.1. Other projects for bibliographical co-ordination are being considered.

Medical History of the War

An editorial board, under the chairmanship of the President of the Board of Education and composed of representatives of the Fighting Services, the Ministry of Health, the Department of Health for Scotland, the Committee of Imperial Defence and the Medical Research Council, has been set up by the War Cabinet to direct the preparation of a "Medical History of the War". The Board met recently and discussed the scope and planning of this undertaking, the value of which as a record of medical work during the War and of the War's contribution to medical science, will be appreciated. Sir Arthur MacNalty, until recently chief medical officer of the Ministry of Health, has been appointed editor-in-chief. The collection and classification of material for the "History" has now begun. The Editorial Board would be glad to receive copies of published articles, reports and other information from medical officers of health and medical practitioners which may be of use in assembling material for the medical historians; such data should be communicated to the Editor-in-Chief, Medical History of the War, Room 208, Caxton House West, Tothill Street, London, S.W.1.

Announcements

It is announced by the New York correspondent of *The Times* that the Mount Palomar Observatory, in California, which is to house the 200-in. telescope, will be closed on January 15 and will remain closed for the duration of the War.

Prof. Louis F. Fieser, professor of organic chemistry in Harvard University, has been awarded the Kathleen Berkan Judd one thousand dollar prize of the Memorial Hospital for the Treatment of Cancer and Allied Diseases, New York City, in recognition of his contributions to cancer research. Prof. Fieser's work in this connexion has dealt chiefly with chemistry and synthesis of carcinogenic compounds.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Lactic Dehydrogenase of Yeast

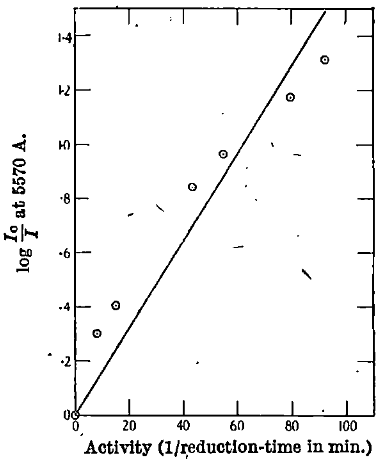
Dehydrogenases are of three types: (1) those which act through coenzymes I or II, (2) flavoproteins, and (3) the 'cytochrome-reducing dehydrogenases', a group of enzymes of unknown chemical nature which have the power of reducing cytochrome *c*. The members of the third group are all insoluble and firmly attached to the solid structure of the tissues, with the exception of the yeast lactic dehydrogenase, first extracted from yeast by Bernheim[1]. This enzyme is, therefore, the only one of the group which can be extensively purified with the view of determining its chemical nature. We have carried out such a purification, and have obtained solutions nearly five thousand times as active as those which Bernheim obtained. The following method was used:

Delft baker's yeast is pressed through an ordinary potato masher and air-dried at room temperature. 3 kgm. dried yeast, mixed with 6 l. tap water, are incubated 5 hr. at 38° for autolysis, then 4·5 l. water are added and the residue centrifuged off and discarded. The liquid (6·3 l.) is mixed with 1 l. of alumina Cγ gel (containing 15 mgm. dry weight per c.c.), which adsorbs much coloured material, including most of the cytochrome *c*. The alumina is centrifuged off and discarded. 140 c.c. 50 per cent sodium lactate are added, the fluid heated to exactly 53° for 7 min. and the large precipitate of denatured protein centrifuged off. The liquid (6·2 l.) is mixed with 3·5 l. calcium phosphate gel (containing 20 mgm. per c.c.), centrifuged and the supernatant fluid discarded. The calcium phosphate is then washed five times, each time with 2·5 l. $M/15$ phosphate buffer *p*H 7·2, by thorough dispersion with a mechanical stirrer and centrifuging. Much protein and coloured material, especially flavin compounds, are thus washed out. The calcium phosphate is then eluted three times at 40° with $M/15$ phosphate *p*H 7·2 containing 9 per cent of ammonium sulphate, using 2·8 l. in all. 10 c.c. 5 per cent sodium lactate is added, the solution filtered and then concentrated to 130 c.c. on the ultra-filter, using "4½ per cent" Schleicher membranes. 31 gm. pure ammonium sulphate are added and the precipitate centrifuged off and discarded. A further 18·5 gm. ammonium sulphate are added, the precipitate centrifuged down and dissolved in water to make 53 c.c. The enzyme is freed from cytochrome *c* by ammonium sulphate fractionation in acid solution as follows: 26 c.c. $M/5$ acetate buffer *p*H 4·8 and 53 c.c. water are added to the above red solution, followed by 37 gm. ammonium sulphate. The precipitate is centrifuged off and discarded. 5 gm. ammonium sulphate are then added, the precipitate centrifuged down and dissolved in water to make 10 c.c.

The enzyme is very unstable in the purer stages. The addition of substrate (lactate) improved the stability, as did a high concentration of ammonium sulphate. But even in saturated ammonium sulphate solution the activity of the purest fractions could only be preserved for 2–3 hr.

The purified fractions of the enzyme have lost the power of reacting with cytochrome *c*, though their power of reducing methylene blue is very high. This effect is apparently due to the removal of some intermediate hydrogen acceptor, which acts[2] between the enzyme and cytochrome *c*.

The solution obtained as described above was quite free from cytochrome *c*, but on the addition of lactate gave the spectrum shown in the graph of a preceding communication[3]. As already stated, this is due to a new cytochrome component and its presence suggests the possibility of its being identical with the enzyme. Although definite proof has not yet been obtained, the following points suggest that this is so. (*a*) The new cytochrome is reduced instantly on the addition of a trace of lactate. (*b*) In different preparations the band at 5570 A. always appears when the enzyme activity reaches a certain value. (*c*) Thereafter the strength of the band and the activity increase *pari passu* as the purification proceeds (see accompanying graph). (*d*) Further evidence is provided by observations on English baker's yeast. The latter cannot be used to prepare the enzyme by the above method, as the enzyme is not liberated by the autolysis, and in order to obtain the enzyme from such yeast a very different method had to be devised. This involved breaking the plasmolysed cells of the fresh yeast by grinding in a ball-mill, warming with toluene, adsorbing on kaolin and eluting with 20 per cent ammonium sulphate, followed by dialysis and adsorption on calcium phosphate as before. When the activity reached the same value as before, the band at 5570 A. again appeared, and in a concentrated fraction obtained in such a way the intensity of the band was approximately that which would be expected from the activity, using the data obtained from the original preparations. No trace of the coenzymes could be detected in the purified preparations by very sensitive tests, and although a trace of flavoprotein was often detectable in solutions obtained by the method described, a slight modification gave active solutions in which no trace of flavin compounds could be detected by the fluorescence test.



While we consider it probable that the cytochrome b_2 is identical with the enzyme, the possibility cannot yet be altogether excluded that it is an intermediary acting between the enzyme and methylene blue or other hydrogen acceptor.

Assuming that the enzyme is identical with cytochrome b_2, the turnover number of the pure enzyme can be calculated from the activity and the amount of cytochrome b_2 present. The figure obtained is

3,100, which can be considered a reasonable value, being in fact identical with the turnover number of crystalline lactic dehydrogenase from muscle[4], though this is no doubt a coincidence, as the two enzymes belong to different groups. The maximum turnover number of cytochrome *c* is 3850[5]. The calculated purity of our final enzyme solutions depends on the assumed molecular weight, but is probably of the order of 10–20 per cent. The Q_{MB} of the pure enzyme would be 30,000–100,000, according to the molecular weight assumed. A calculation from the activity of the Lebedew juice shows that 1 kgm. of yeast contains only a few mgm. of the pure enzyme.

The idea that a cytochrome, or indeed any other hæmatin compound, may act as a dehydrogenase is a new one and may throw light on the nature of other dehydrogenases of the third group.

The work will be reported in greater detail elsewhere.

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[1] Bernheim, F., *Biochem. J.*, **22**, 1178 (1928).

[2] Dixon, M., and Zerfas, L. G., NATURE, **143**, 557 (1939).

[3] Bach, S. J., Dixon, M., and Keilin, D., NATURE, **149**, 19 (1942).

[4] Straub, F. B., *Biochem. J.*, **34**, 483 (1940).

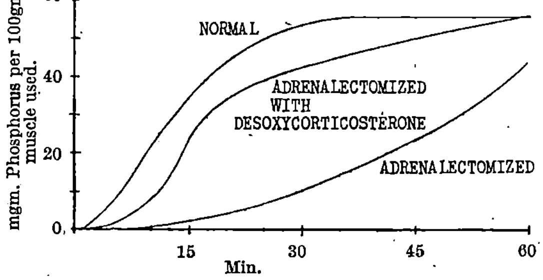
[5] Keilin, D., and Hartree, E. F., *Proc. Roy. Soc.*, B, **129**, 227 (1940).

Decrease in Glycogen Phosphorylation in Muscles *in vitro* after Adrenalectomy and Restoration with Desoxycorticosterone

IT has been supposed that a diminution of phosphorylation is the main disturbance after adrenalectomy, and that this is proved by a study of the direct phosphorylation of glycogen by muscle.

If 0·5 gm. of leg muscle of a normal rat is minced and placed in 2 c.c. of a solution of 1 per cent sodium bicarbonate with 1·75 per cent sodium fluoride, then inorganic phosphate is dissolved from the muscle. If 0·25 per cent of glycogen is then added to such a solution, the inorganic phosphoric acid content of the solution decreases and the glycogen is phosphorylated (Bodnár and Tanko, Lohmann, Parnas). The muscles of adrenalectomized rats lose this capacity of phosphorylating glycogen *in vitro*. This was first shown by Schumann (1940), but simultaneously Helve (1940) did not find this difference.

We have studied the time relations of this reaction with the muscles of normal and adrenalectomized rats. Normal rat muscle uses about 54 mgm. phosphorus per 100 gm. of muscle. At 20° C. the reaction ends in 30–60 minutes, and at 37° C. in 10–20 minutes. With muscles of adrenalectomized rats, the reaction is much slower and within the physiological time limit it is strikingly decreased. In thirty-seven adrenalectomized rats only about 11 mgm. phosphorus was used up after thirty minutes. The reaction then slowly continues and may, after three hours, give values equal to those found in normal muscle after thirty minutes at 20° C. or after twenty minutes at 37° C. This explains why Helve, who kept the muscle at 37° C. for 3½ hours, did not observe a decrease in phosphorylation.



PHOSPHORYLATION OF GLYCOGEN BY RAT MUSCLES *in vitro* AT 20° C.

The accompanying figure shows the time relations of the reaction based on mean values of experiments on normal and adrenalectomized rats' muscle at 20° C. The decrease in phosphorylation in the latter is obvious. It is already found in animals which are still only slightly adynamic. Only animals which were still in good condition were used for these analyses. Generally speaking the more time had elapsed after the adrenalectomy, the less phosphorylation occurred. Table 1 gives some values at 20° C. after sixty minutes and at 37° C. after twenty minutes for comparison.

Table 1.

MGM. PHOSPHORUS PER 100 GM. MUSCLE USED.

Normal rat muscle (21 animals)	45–64 (mean 54)
On 4th day after adrenalectomy	26, 22
,, 5th ,, ,, ,, ...	36, 36, 22, 40, 22
,, 6th ,, ,, ,, ...	28, 26, 20, 26
,, 7th ,, ,, ,, ...	8, 4, 39, 15, 8
,, 8th ,, ,, ,, ...	6, 20, 16, 18

(Each figure refers to a separate rat)

We then tried to restore phosphorylation by adding desoxycorticosterone acetate to these muscles *in vitro*. A 1 per cent solution in 66 per cent propandiol-water was made and 0·1 c.c. added to the system described of 0·5 gm. muscle with glycogen. Desoxycorticosterone restored the decreased rate of phosphorylation with muscle of adrenalectomized rats to the normal rate in all cases (muscles of twelve animals at 20° C., and four at 37° C.); it did not increase the rate of glycogen phosphorylation of normal rat muscle where it was already optimal (three experiments). As a control the action of other steroid hormones, œstradiol and similarly of testosterone, was compared. Neither of these hormones had any action whatever on the rate of phosphorylation, with normal or adrenalectomized rats' muscle.

Table 2.

MGM. PHOSPHORUS PER 100 GM. MUSCLE USED.

	Desoxycorticosterone (Without)	Desoxycorticosterone (With)
On 4th day after adrenalectomy	20	36
,, ,, ,, ,, ,, ...	42	54
,, 5th ,, ,, ,, ...	36	64
,, ,, ,, ,, ,, ...	48	68
,, 6th ,, ,, ,, ...	26	40
,, ,, ,, ,, ,, ...	28	52
,, 7th ,, ,, ,, ...	39	62
,, ,, ,, ,, ,, ...	8	30
,, 8th ,, ,, ,, ...	10	19
,, ,, ,, ,, ,, ...	18	30

These experiments seem to give a proof that phosphorylation disturbances are the main factor in adreno-cortical insufficiency. It must be emphasized that the restoration took place not in the animal but *in vitro*. A detailed report will be given in *Helvetica Chimica Acta*.

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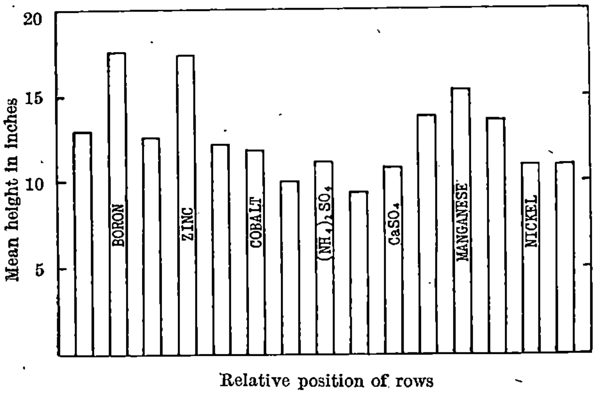
Trace-elements and 'Potato-sickness'

IT is well known that infestation with the potato strain of the eelworm *Heterodera schachtii* Schmidt is not the sole cause of the disease known as 'potato-sickness'. It occurred to me that some nutritional deficiency might be a contributory factor. The disease nearly always occurs on land on which potatoes have been grown continuously for a number of years, and it seemed possible that this might well lead to the soil being exhausted of certain vital elements required by the plant in small quantities and normally neglected in manurial treatments and soil analyses. A small-scale attempt to test this hypothesis was made during 1941 and some promising results obtained. These, however, were of a preliminary nature and a more extensive investigation is planned for the future. A detailed account of this year's work is now in preparation; in the meantime it was thought advisable to publish the following note in the hope that it might be of use to other workers who may be interested in the problem.



MEAN HEIGHTS OF THE GROUPS OF FIVE PLANTS IN THE MOST DILUTE ZONE SHOWN IN THEIR RELATIVE POSITION IN THE PLOT. UNTREATED ROWS ALTERNATE WITH TREATED ROWS. THE ROW MARKED '$CaSO_4$' RECEIVED A HEAVY DRESSING OF THIS SUBSTANCE IN POWDER FORM IN THE DRILL AT THE TIME OF PLANTING. SIX OTHER ROWS OF PLANTS IN A SEPARATE BLOCK ARE NOT SHOWN IN THIS FIGURE.

A small plot of land, badly infested with *Heterodera schachtii*, was planted with a series of rows of potatoes, each row containing fifteen plants. Some of the rows were watered, at weekly intervals, with dilute solutions each containing a single salt of certain of the trace-elements. The strength of the solution was halved for each successive group of five plants in the row. Three strengths of the various solutions were thus used, and of these, the solution applied to the second five of the fifteen plants was of the same strength as that contained in the solutions used by Arnon in his work on the effect of trace-elements on the growth of lettuce and asparagus seedlings[1]. Treated and untreated rows alternated throughout most of the plot, so that there was, in general, an untreated row on each side of a treated row. Certain of the rows were treated with ammonium salts of similar dilution to act as general controls and also to control any possible effects of the anions of the salts of the various trace-elements used.

The heights of all the plants were measured when flowering began, when it was noticed that all the plants were at the same stage of maturity. The crop was lifted when the last of the tops had died down, and the tubers of each plant weighed.

Weight of crop and height of plant were in general agreement.

The mean height of each group of five plants in the rows varied with the dilution of the solution used, the plants being considerably taller in the zone to which the strongest solutions had been applied, and shortest where the most dilute solutions had been used. The most striking *differences* between treated and untreated plants were shown, however, in the latter zone. For example, the mean height of the plants treated with the most dilute solution of zinc sulphate was 40 per cent greater than the mean height of the untreated plants on each side of them. A similar difference was also found in the case of boric acid, and a smaller, but quite marked, difference in the case of manganese chloride. Yet these treated plants had received extremely minute amounts of the trace-element. For example, *throughout the whole season*, the total quantity of boron supplied to each of the plants treated with boric acid was about 0·5 mgm., while the total quantity of zinc supplied to each plant treated with zinc sulphate was about 0·05 mgm. It is certain that the increases in height were not due to the water supplied, for the differences are just as marked when the treated plants are compared with plants treated with water alone or with those treated with the dilute solutions of the various ammonium salts. Some of these points are clearly shown in the accompanying figure.

The plants treated with the more concentrated solutions showed the same general effects, save that the percentage differences between treated and untreated plants were not so large. It is probable that, under the conditions of the experiment, the treatments spread to the adjacent untreated rows and that this tendency was greater the stronger the solution used. It was also evident that the plot was by no means homogeneous in degree of infestation with eelworm, but although this would help to explain the fact that the tallest plants were all found in the zone to which the strongest solutions had been supplied, it cannot account for the marked differences between the treated plants already referred to and those immediately adjacent to them.

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[1] Arnon, D. I., *Amer. J. Bot.*, **25**, 322 (1938).

Cotton Seed Disinfection in War-time

IN the Sudan cotton seed has to be treated with a mercurial dust for the control of blackarm (*Bacterium malvacearum* E.F.S.), present on the seed as an external infection[1,2].

On the outbreak of war the possibility arose of there being a shortage of mercurial dusts in the country. It therefore became expedient to provide an alternative method for the disinfection of cotton seed in the event of such an emergency.

B. malvacearum in cotton debris is destroyed when cotton fields are flooded for a period of four days with irrigation water[3]. The disappearance of the organism is attributed to the action of a bacteriophage. Experiments were performed to discover whether *B. malvacearum* on cotton seed could be destroyed in a similar manner.

It was found that after steeping cotton seed for forty-eight hours in four times its own weight of irrigation water practically all traces of external infection by *B. malvacearum* had disappeared. In small-scale plant-house experiments on seed which when untreated gave 14 per cent infected plants, complete control of the organism was obtained. A larger field experiment, using infected seed from the same source, gave 0·26 per cent infected plants after the steeping treatment, and complete control after using a mercurial dust, Abavit B.

Germination of the seed is depressed by the steeping treatment, but not seriously so. In a field experiment unsteeped seed gave 79 per cent germination, and steeped 72 per cent. The steeped seed had been dried and stored for a short period after treatment. If the steeped seed cannot be sown wet immediately, and has to be dried and stored, the drying process must be rapid and thorough. Otherwise the seed will promptly germinate.

From laboratory experiments it would appear that the organism disappears from the surface of the seed during steeping, not through the activity of a bacteriophage, but through exposure to anaerobic conditions. These conditions are the result of bacterial activity, and oxygen absorption by the germinating seeds. The growth of *B. malvacearum* in culture is closely conditioned by the amount of oxygen present.

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[1] Massey, *Emp. Cot. Grow. Rev.* **14**, 301 (1937).

[2] Clouston and Andrews, Rep. Agr. Res. Serv. (1938).

[3] Massey, Rep. Gezira Agric. Res. Serv. (1933 and 1934).

Scattering of Neutrons in Deuterium

USING the neutrons released in the beryllium-deuterium nuclear reaction, we have investigated the scattering of medium fast neutrons in deuterium gas. The bombarding deuteron beam of 4 micro-amperes was accelerated with a peak voltage of 600 kilovolts in a short ion path tube[1], using the 1 Mv. cascade transformer at the California Institute of Technology. The neutrons emitted in a direction perpendicular to the bombarding deuteron beam traversed a brass pressure ionization chamber filled with deuterium gas at 7 atmospheres. The energy of the recoil deuteron was measured by a linear amplifier which fed a mechanical oscillograph, the pulses being recorded on a moving film. Calibration pulses were registered on the same film with a thyratron pulse generator and a standard condenser. More than 4,000 tracks were measured, the longest pulse track corresponding to an energy of 2 Mev. The curve giving the distribution in energy is shown in Fig. 1.

The maximum at 1·2 Mev. may correspond to the peak energy of the low-energy group of neutrons[2] released in the beryllium-deuterium reaction. The more prominent maximum at 0·7 Mev., presumably, is due to an anomaly in the neutron-deuteron interaction. It may be associated with the "Ramsauer effect" deduced[3] by Massey and Mohr on the basis of a potential interaction of range $4\cdot5 \times 10^{-13}$ cm. Assuming the approximate validity of the equation deduced by Baldinger *et al.*[4] for the distribution in energy of the primary neutrons in terms of the energy distribution of the recoil nuclei, the curve in Fig. 2 has been plotted with the cross-section values given by Massey and Mohr (*loc. cit.*). The graph indicates a wide spread of energy in the neutron beam, which gets scattered in the gas contained in the ionization chamber. The anomaly at 0·7 Mev. may also be associated with the critical wave-length $\lambda_{cr} = 5\cdot4 \times 10^{-13}$ cm. deduced by Bethe[5] on the basis of a continuum theory of the compound nucleus. As recently stressed by Massey and Buckingham[6], further experimental data may be needed to establish the nature of fundamental nuclear forces.

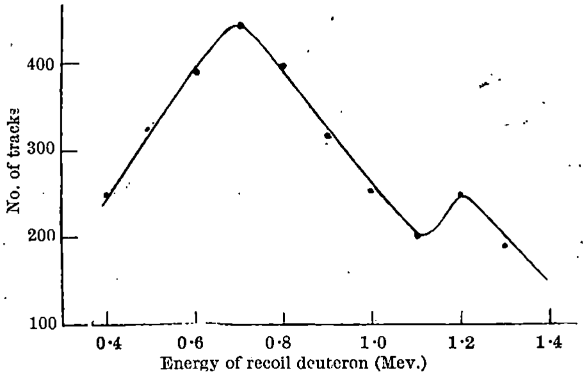

Fig. 1.

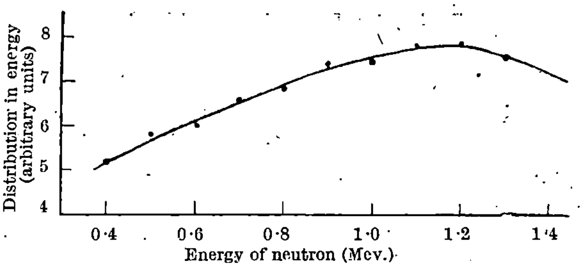

Fig. 2.

The details of our experimental work will appear elsewhere.

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[1] Stephens and Lauritsen, *Rev. Sci. Inst.*, **9**, 151 (1938).

[2] Bonner and Brubaker, *Phys. Rev.*, **50**, 308 (1936).

[3] Massey and Mohr, *Proc. Roy. Soc.*, A, **148**, 206 (1935).

[4] Baldinger, Huber and Staub, *Helv. Phys. Acta*, **11**, 245 (1938).

[5] Bethe, *Phys. Rev.*, **57**, 1125 (1940).

[6] Massey and Buckingham, NATURE, **146**, 776 (1940).

Anomalous Viscosity of Lubricating Oil at High Velocity Gradients

AN analysis of data recently put forward by Spiers[1], on the flow of oil through engine bearings, shows that the results cannot be reconciled with the usual hypothesis of a viscosity coefficient independent of the velocity gradient. The data indicate that at velocity gradients between 10^4 and 10^6 sec.$^{-1}$, the viscosity coefficient falls down to a small fraction of its normal value. This effect is in agreement with experiments carried out by me in 1937[2]. It is presumably due to orientation under shear, an effect well known for particles of extreme anisometry such as those of cellulose and tobacco mosaic virus.

The analysis of Spiers's data will be published shortly. Experimental work on the problem is in hand.

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College of Technology,
Manchester, 1. Dec. 18.

[1] Spiers, *J. Inst. Auto. Eng.*, vii (Jan., 1941).

[2] Neale, *Chem. & Ind.*, 140 (1937).

RESEARCH ITEMS

Blackening of Golgi Bodies by Osmium Tetroxide and Silver Nitrate

The problem of the blackening of the Golgi apparatus in various silver and osmic techniques is an old and still unsolved one. Among recent investigations those of P. B. v. Weel and E. Ries are interesting. In a recent communication to the Editors, they claim that there is a Golgi complex containing certain granules which they call "lipochondria", which at some stages produce osmiophilic substances, and are associated with the fatty Golgi substance, which always reduces osmium tetroxide, and has certain adsorptive capacities. Weel notes that after feeding a starved frog (in the cells of the intestine of which a clearly marked reticular Golgi apparatus is present) on peptone and glucose, the reticulum disappears, and is rebuilt again at the end of the resorptive process. But with feeding on fructose, no alteration of the reticulum was noted. Weel insists that the Golgi substance contains fatty materials which are used and consumed by the cell in certain periods of activity. The results of Weel and Ries are sharply at variance with those of G. Chr. Hirsch, who believes that the blackening is due to an adsorption of reduced osmium, silver or iron, and not to any chemical action. While Weel's view, that the osmium tetroxide reaction is a chemical one with lipins existing in the Golgi apparatus, will meet with a considerable body of support, the presence of "lipochondria" seems more doubtful. The papers of Weel and Ries will be found in the *Z. Zellforsch.* and the *Z. vergl. Physiol.* of 1936–1939.

Salmon of the Owenduff (Ballycroy) River

A. W. E. J. Went, of the Department of Agriculture, Fisheries Branch, Dublin, (*Proc. Roy. Irish Acad.*, **47**, Sect. B., No. 6; 1941) has investigated the fishes in this river—a good one for small salmon and sea-trout. The records for the most part depend on scales from rod-caught fish, but give a fairly accurate impression of the stocks of salmon. The bed of parts of the main river and its tributaries which are frequented by salmon and trout consists mainly of gravel, and good spawning facilities are available. The material for the research consisted of more than a thousand sets of scales and data taken from the rod-fisheries of the Owenduff River during the fishing seasons of 1930–1939 inclusive, and 106 similar sets from the net fishery in the estuary of the river in 1938, together with some data from the main tributaries. Owenduff is essentially a small salmon river and the bulk of the fish have spent two years or less feeding in the sea. Of the maiden fish 94 per cent migrated as two-year old smolts and 5·5 per cent as three-year old smolts. Grilse and small spring fish formed 75·8 of the total catch. Previously spawned fish amounted to 4·9 per cent of the total number. The growth of salmon and sea-trout up to the end of the second year in the sea in the two- and three-year smolt classes are compared. The growth-rate of the salmon in fresh water is considerably less than that of the sea-trout. On the other hand, in the sea the growth-rate of the salmon is very much greater than that of the sea-trout. "Although the sea-trout start life in the sea with an initial advantage in length of over 2 inches, by the end of the first winter in the sea the salmon are on an average about 7 inches longer than the sea-trout. This advantage is more than maintained in the second year in the sea."

Microlepidoptera of Ireland

The study of these small moths has been comparatively neglected in Ireland, and generally it is the larger species of the Microlepidoptera that are best known. It appears that the Tortricidæ and Lampronidæ are the best-worked families, and the most neglected are the minute Nepticulidæ. B. P. Beirne has published an up-to-date list of all the species so far known or believed to occur in Ireland (*Proc. Roy. Irish Acad.*, **47**, Sect. B, No. 4). He records 709 species or 54 per cent of the British Microlepidoptera. Of these, 105 species are bracketed as incorrect or doubtful, thus leaving 46 per cent definitely recorded. The classification followed is that of Meyrick, which has been corrected and brought up to date. In describing the distribution of each species, the county-divisions of Praeger, as used in his "Irish Topographical Botany", are followed. In a country that has been so little explored for these insects remarks on the abundance or otherwise of a species are usually not very reliable. It appears that the best-worked county is Dublin, and along with Wicklow and Kerry these three counties are the only ones explored for the smaller species. This carefully prepared list will prove of great assistance to future collectors and observers, who will also find the bibliography at the end very helpful.

Transmission of Monosomics

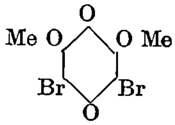
W. H. Greenleaf (*Proc. Nat. Acad. Sci.*, **27**, 427–430; 1941) has analysed the transmission of *n*-1 gametes through the ovule of the monosomic-*P* of *Nicotiana tabacum.* Although a ratio of 3 monosomics to 1 normal plant is expected, only 4 per cent monosomic–*P*, are found. There is no Renner effect; every embryo sac is formed from the megaspore at the chalazal end. There is, however, a reduction in the number of seeds in a monosomic, and the author shows that the embryo-sacs arising from *n*-1 megaspores are much delayed in development as compared with normal. He suggests that delayed pollination might increase the proportion of monosomics in the progeny.

Phosphorus Trifluoride and Oxyfluoride

The reactions between phosphorus pentoxide and simple fluorides and chlorides and with fluorapatite have been studied by G. Tarbutton, E. P. Egan and S. G. Frary (*J. Amer. Chem. Soc.*, **63**, 1782; 1941) and the physical properties of PF_3 and POF_3 have been re-examined. The melting and boiling points found are: PF_3, m.pt. −151·5°, b.p. −101·8; POF_3, m.p. −39·1° at 785 mm. (it sublimes at −39·5°), b.p. −39·7°. The vapour pressure curves were determined and the latent heats calculated. A small amount of difluophosphoric acid HPO_2F_2 (b.p. 108°–111°) was isolated; no previous record of this compound could be found.

Hexamethoxybenzene

In the course of some experiments on derivatives of pentahydroxybenzene, hexamethoxybenzene has been prepared by Sir Robert Robinson and C. Vasey (*J. Chem. Soc.*, 660; 1941). A solution of tetramethoxydiacetoxybenzene in methyl alcohol by hydrolysis and methylation gave hexamethoxybenzene, white needles, m.pt. 81°, b.pt. *ca.* 278°, readily soluble in common organic solvents and moderately readily soluble in water; it can be recrystallized from hot water. The starting substance for the preparation of the tetramethoxy compound was dibromodimethoxy-*p*-benzoquinone:



This was converted by sodium methoxide in methyl alcohol into tetramethoxy-*p*-benzoquinone, and by the action of zinc dust in acetic acid-sodium acetate solution the tetramethoxydiacetoxy compound was obtained. Hexahydroxybenzene is also formed by another process described by W. Baker (*J. Chem. Soc.*, 663; 1941).

Steady Flow of a Viscous Fluid through a Leaky Tube

The classical work of Poiseuille on the steady flow of a viscous liquid through straight tubes of uniform circular section and with impervious walls is not directly applicable to conditions arising in biological problems. Here a similar flow occurs through tubes with membranous walls such as the fine capillaries through the walls of which nutritious fluids get from the blood to working (for example, muscle) cells. F. J. Turton (*Phil. Mag.*, 32, 457; 1941) gives a theoretical treatment of this type of problem applicable to data supplied from the Cambridge Biochemical Laboratory by J. F. Danielli. The investigation shows that with leaky walls the pressure gradient may approximate closely to the constancy found with non-leaky tubes, but for certain conditions known to exist in practice, the mathematical results show considerable departure from constant pressure gradient. At the end of the paper the author offers to help any biologist wishing to use the mathematical results.

Solutions of Wave Equations

Prof. E. Schrödinger, now at the Dublin Institute of Advanced Studies, invites the collaboration of mathematicians in the detailed investigation of certain new types of wave equation. He points out (*Proc. Roy. Irish Acad.*, 47, 1; 1941) that a decisive advance in quantum theory was made in 1934 by the hypothesis of E. Fermi. This asserts that just as Maxwellian waves are descriptive of the motion of light-quanta, but responsible for the forces between electrically charged particles, so the wave fields of de Broglie-Schrödinger-Dirac are descriptive of electrons but responsible for a new kind of forces between heavy particles. The mathematical expression of this leads to wave equations of a new type, and it is very desirable that the solutions of these equations should be fully investigated. A method which seems likely to be very useful is that of taking mean values over a sphere. This method reduces the number of independent variables from four to two. There is also a much more general method which is applicable to the "enlarged wave equation" of any conservative system, but it is not clear whether, in practice, this is as useful as what appear to be more special devices.

Magnitudes and Colours of Northern Stars

The measurement of stellar brightness and colour depends so much on instrumental and atmospheric conditions that photometric catalogues prepared at various observatories are apt to exhibit large discrepancies. The establishment by the International Astronomical Union, twenty years ago, of the North Polar Sequence of standard stars was not altogether successful in removing these difficulties, mainly because the standards were too few, too bright, and too scattered. The obvious remedy was to increase the number of standards. Nearly ten years work to this end at the Mt. Wilson Observatory has now culminated in the issue of a Catalogue (Carnegie Institution of Washington, Publication 532; 1941) of magnitudes and colours for 2,271 stars north of declination +80°. Work on the new catalogue began by a systematic intercomparison of nine well-known polar catalogues; the provisional magnitudes so deduced prepared the way for the reduction of the more recent photographic observations (more than a hundred plates) on which the catalogue chiefly depends. These plates were taken with the 5-inch Ross camera at Mt. Wilson, and were measured in thermo-electric photometers. The limiting magnitude adopted was that of the B.D. Catalogue, roughly 11·0 photovisual. The magnitudes catalogued, photographic and photovisual, are given to two decimal places, and are weighted means of the new data and the older catalogue values, though the new values are also given separately. The probable error of a catalogue entry is about ±0·012 mag. for a photographic, and ±0·015 mag. for a photovisual value. These definitive magnitudes seem likely to supersede the old standards at once; and the scope of the catalogue is such that they may have an even longer life than the values they displace.

Polarization of the Corona

G. W. Allen has published a paper (*Mon. Not. Roy. Astro. Soc.*, 101, 5; 1941) which contains the polarization observations made on the solar corona by the Australian Eclipse Expedition to South Africa on October 1, 1940. The chief object of the investigation was to determine to what extent the polarization of the corona varied with colour. The camera was fitted with a 6-inch Dallmeyer lens of focal length 36 inches. It was fed from an 8-inch cœlostat with silvered mirror and gramophone motor drive. About an inch in front of the plate a 2½-inch disk of 'Polaroid' was placed in such a way that it could be rotated through 90°, and it was oriented to rotate from a polar to an equatorial direction. Interchangeable blue and red filters were mounted between the plate and the 'Polaroid' and two exposures were made on each plate, one with the 'Polaroid' oriented in a polar direction and the other with equatorial 'Polaroid'. One great difficulty in corona photometry arises from the correction for fogging by extraneous light, and at great distances from the sun on the long exposures this extraneous light was much brighter than the corona. The calibration of the photographic plates was effected by the use of a platinum step wedge placed in contact with the plate, and exposure was made inside the camera with the same colour filters, 'Polaroid' and plates as were used for the eclipse. A full description is given of the measurements of the photographs with the Radcliffe Observatory, Pretoria, photo-electric microphotometer, of corrections which were made owing to the incompleteness of the polarization of the 'Polaroids', etc. It was found that the polarization of the corona was practically independent of colour from 4600 A. to 6250 A. and also that it was almost independent of limb distance from 7′ to 40′. The degree of polarization was 41 per cent for red and 43 per cent for blue light.

HETEROTHALLY AS AN OUT-BREEDING MECHANISM IN FUNGI

By DR. K. MATHER

John Innes Horticultural Institution

ALL organisms are dependent on a supply of heritable variation for future adaptive changes; but the presence of free variation means that some members of the population show a poor adaptation to existing circumstances. The balance between present and future adaptation is thus conditioned by the amount of heritable variation which the population can maintain. This, in its turn, depends on the system of breeding or mating in force in the species. Where close inbreeding is in force the individuals tend towards a high degree of homozygosity. Heritable variation is then reduced to a low level, with the result that present adaptation is good but the prospect of future adaptation to changed circumstances poor. When, on the other hand, outbreeding is the rule, great genetical heterogeneity is maintained and in consequence the chances of good future adaptation are improved at the expense of present fitness[1]. In this way genes which control or affect the breeding system of a species have a profound effect on its genetical structure and evolutionary history. They have an adaptive value and will be subject to evolutionary changes.

Many genetically controlled breeding systems have been recognized, and some partly analysed, in the higher plants. Sex separation, incompatibility and heterostyly are now well known as outbreeding systems which depend for their action on genetical diversity in the population. In each case the action of the mechanism is by the reduction of effective mating between genetically like zygotes, while genetically unlike individuals intercross with relative freedom. In the extreme, and most common, case this reduction is complete, though in other cases it may only be partial. The extent of the reduction is itself subject to further genetical control[2]. Since male and female gametes are always distinct haploid individuals, the achievement of wide outbreeding is ensured by the complete prevention of fusion between gametes from the same zygote. All three of the mechanisms mentioned render this possible.

Though showing the same genetic organization as Angiosperms, the fungi, and indeed nearly all lower plants, may be expected to present somewhat different types of breeding system for two chief reasons. In the first place the mating behaviour is a property of the haploid phase in the life-cycle, unlike the situation in the higher forms where the diploid zygote plays such a predominant part. The genes determining the breeding system in fungi must act solely in the haploid, after it has become freed from the influence of the parent zygote. Secondly, a given haploid individual may produce both male and female gametes, or, amounting to the same thing, gametic differentiation may be lacking, in contradistinction to the higher plants where the haploid phase is almost non-existent except in the form of the individual gamete. In view of these differences it is very instructive to consider the type of genetically controlled outbreeding system which might be operative in lower plants, and Buller's recent review of heterothally in fungi[3] provides a very suitable opportunity.

What kind of breeding system, involving genetical diversity, might be expected *a priori* in fungi?

The first essential of any outbreeding system in a species with an independent haploid phase is the prevention of fusion between two gametes produced by a single haploid individual. (It may be noted in passing that this occurrence would lead to a more rigorous inbreeding than is ever possible in a species having a predominant diploid phase, as such self-mating gives immediate homozygosis.) Assuming that the same broad possibilities of cell behaviour exist here as in the Angiosperms, self-mating of a haploid may be prevented in either of two ways. The male and female gametes, if distinct, may be isolated on different haploids or an incompatibility gene may operate in such a way that only haploids carrying unlike allelomorphs can mate. Where gametic differentiation is not present the former possibility is ruled out; but in any event the two systems have a similar genetical basis, for each depends on the production of two (or, in the second case, possibly more) genetically distinct haploids, the allelomorphs determining the two groups acting so as to prevent mating of like types.

Whether the action is one by which allelomorph A_1 gives a haploid with male gametes and A_2 one with female gametes, or whether the action of A_1 and A_2 is of the physiologically unanalysed type known in the higher plants by the name of incompatibility, is genetically immaterial. In either event the matings $A_1 \times A_1$ and $A_2 \times A_2$ are impossible and self-mating of a single haploid is ruled out. Prevention of self-mating in its simplest form requires only two allelomorphs A_1 and A_2. The existence, possible with an incompatibility system, though not with sex separation, of more than two types of haploid does, however, have an advantage over the two-group system when we turn to the next aspect of inbreeding prevention, namely, the control of mating between haploids having a recent common ancestry.

Even if self-mating is prevented, a considerable measure of inbreeding is possible provided that haploids deriving from the same diploid zygote, where, it should be remembered, the all-important recombination occurs, can mate as freely, or more freely, *inter se* than they can with haploids descended from other zygotes. Inbreeding at this level cannot be prevented or even reduced by any system of incompatibility or sex-separating genes consisting solely of allelomorphic pairs. Where a single allelomorphic pair exists all the zygotes must be A_1A_2 and will give A_1 and A_2 haploids. Furthermore, all the zygotes will give equal proportion of A_1 and A_2 haploids; so in any population the ratio which the numbers of A_1 haploids deriving from a given zygote bears to the number of A_1's from other zygotes will on the average be the same as the ratio of the A_2 haploids contributed by these various zygotes. Hence an A_2 gamete will find possible mates from different zygotes in the proportions of the contributions of any kind of spore by those zygotes to the population. The same will be true of the mating choice open to A_1 haploids and so the relative rate of mating between sister haploids from the same zygote is independent of the existence of the two allelomorphs, A_1 and A_2.

Thus all that this pair of allelomorphs does, other than to prevent self-mating, is to halve the number of possible mates for a given haploid individual in the population. It can mate with half its sisters, that is, with the A_2's if it be A_1, or A_1's if it be A_2, just as it can mate with half the haploids from any other zygote.

Two elaborations of this simple system are possible *a priori*, one of which will decrease the frequency of mating between sister haploids and the other of which increases the frequency of mating between non-sisters. The first one is the introduction of a second independent locus B, such that $B_1 \times B_1$ and $B_2 \times B_2$ are impossible matings while $B_1 \times B_2$ is possible. This new gene has, in fact, just the same action as the gene A. All zygotes must be $A_1A_2B_1B_2$ and will produce four types of daughter haploid, A_1B_1, A_1B_2, A_2B_1, A_2B_2. Only two matings are possible between the four, namely, $A_1B_1 \times A_2B_2$ and $A_1B_2 \times A_2B_1$, all the others being prevented either by gene A or by gene B, or, of course, by both. Self-mating is, obviously, also impossible. Any given haploid can mate with only one of the four types, so that only one quarter of the possible combinations in pairs are fertile in the sense that they can give progeny. This compares with the half given by a single gene. When a third member, C, is introduced the freedom of mating is reduced to one eighth.

This type of elaboration certainly reduces the chance of a successful mating between haploids from the same zygote, but, as all zygotes must be $A_1A_2B_1B_2$, it equally reduces the chance of successful mating between haploids from different zygotes. The latter may, however, be increased by the second elaboration. So far in the argument each gene has comprised two allelomorphs, but if a multiple allelomorphic series exists at each locus the freedom of non-sister mating is increased. Suppose that locus A has three allelomorphs, A_1,A_2 and A_3. Three types of zygote will occur, namely A_1A_2, A_1A_3 and A_2A_3. A haploid can mate with only half its sisters from the same zygote, but it can mate with more than half its non-sisters ; for one type of zygote, and, it must be noticed, the most unlike and hence the most distantly related, type of zygote, gives daughter haploids with all of which the first haploid is fertile as it differs genetically from them all. When the three types of zygote are equally frequent the non-sister pairs can mate in 2/3 of cases as compared with the sister mating figure of 1/2. When there are four allelomorphs still more types of zygote are possible and non-sister mating is again increased to 3/4. Non-sister mating increases as the number of allelomorphs increases, but sister mating remains at 1/2.

This increase in the freedom of non-sister mating may be combined with decreased sister mating if several genes each of several allelomorphs are in operation. With two genes each of three allelomorphs, that is, A_1 A_2 A_3 and B_1 B_2 B_3, all allelomorphs being equally frequent in the population, sister mating occurs in 1/4 of cases and non-sister mating in 4/9, giving a non-sister : sister ratio of 16 : 9. This compares with 4 : 3 when only one gene of three allelomorphs is in control. With two genes of four allelomorphs the ratio is 9 : 4, that is, the rate of outbreeding as measured by relative frequency of non-sister and sister mating is once again increased. Thus by a combination of several unlinked incompatibility loci each with several allelomorphs a high rate of outbreeding can be achieved. It may be noted, however, that mating between haploids from the same zygote can never be completely prevented in the way that any of the three breeding systems mentioned earlier for higher plants completely prevents it. To do this would require that the diploid phase could implant in all its daughter haploids some single incompatability character which overrode their own constitution and determined their behaviour in mating. This is in fact done by higher plants [2,4], but, perhaps as a result of the lower degree of organization of diploid life, has not, so far as I know, been encountered in any lower plant.

When Buller's review is examined in the light of this system, built up from principles developed to explain the behaviour of Angiosperms, it will be seen that all levels of elaboration, and hence of controlled outbreeding, are found.

In forms like *Coprinus lagopus* and *Schizophyllum commune* the complete system involving multiple allelomorphic series at more than one locus is found. It may be remarked that, when viewed in this new light, the true nature of the so-called sexual races of these fungi is very clear. They are no more races than are any pair of fully cross-compatible plants in species like the sweet cherry and the red clover. The different diploid fruit bodies, which, by being fully inter-fertile, gave rise to the idea of sexual races, are seen merely to have different allelomorphs at each of the incompatibility loci which, taken together, control the breeding system. The next generation from a cross between such diploids would contain sister zygotes which, on this criterion, could equally well be classed as belonging to different sexual races. It can be predicted that a suitable search should bring to light wild fruit bodies which have one allelomorph in common at either or both of the loci. These would exhibit an inter-fertility which, though incomplete, would be greater than that observed when haploids from the same fruit body are interbred. Such a find would complete the evidence for the artificiality of the sexual race concept.

There are also examples of intermediate elaboration where only one incompatibility locus is found. Though apparently less fully investigated from the point of view of multiple allelomorph detection, at least one of these species, *Coprinus rostrupianus*[5] has such a series. No doubt other cases could be found without much difficulty.

The last stage of control is shown by fungi such as the heterothallic Mucor species where a single gene of two allelomorphs prevents self-mating but where the degree of outbreeding beyond this point is a matter of chance. Sometimes this mechanism appears to survive as a relic after another form of control has been superimposed. Such a case is provided by certain Ustilago sp., for example, *U. hordei*[6] where the four products of meiosis unite in pairs in the single-celled stage, at which self-mating would appear to be ruled out in any case. An inbreeding system has been developed by the retention of the four spores in such a way that the most likely pairings are those between unlike products of the same meiosis, that is, of the same diploid zygote. It would appear that this is an example of adaptation to secure an intermediate degree of inbreeding similar to those obtaining in higher plants like Triticum and Pisum. In these higher plants, too, the present inbreeding mechanism has been superimposed on an outbreeding system, the relics of which may still be observed.

Lastly, there are the cases where heterothally is not found and self-mating may occur. Such homothallic species are capable of rigorous inbreeding, but this may be controlled at an intermediate level by a display of incomplete or partial heterothally. When this happens a haploid is capable of self-mating, that is, of homothallic behaviour, but will in particular circumstances show a preference for mating with other individuals, that is, show heterothallic behaviour. It is as though the individual possessed partially effective heterothally genes. In this way a balanced inbreeding-outbreeding system can be maintained.

It is also possible that such behaviour exists as a stage in the transit between full homothally and full heterothally. In *Primula sinensis*[2] and Petunia sp.[7] the efficiency of the key outbreeding genes is probably controlled by modifying polygenes. The main genes for heterostyly in the one case and for incompatibility in the other may then give either increased or decreased outbreeding by selection of the polygenic complex. Though not yet proved, it seems likely that selection could even reduce the efficiency of the outbreeding genes to zero, that is, completely to remove their power of affecting the breeding system. If this is so, it is easy to see that polygenic selection could lead to the gradual development of an adaptive breeding mechanism. The intermediates between homo- and heterothallic behaviour are susceptible to a similar interpretation and this could be tested by suitable selection experiments. The question of how a + and a – nucleus can occur in different parts of the same homothallic haploid then resolves itself, as, on this view of polygenic modification, the nuclei, though capable of developing heterothallic behaviour, will not inevitably possess a 'sex'.

Such a brief survey forbids the detailed mention of special cases, but it can be seen that the complications of heterothally fit into an ordered scheme when viewed as adaptations to the control of outbreeding. Basically, the function and genetical structure of heterothally are the same as those of systems found elsewhere. The superficial differences are imposed by peculiar circumstances arising from the existence of an independent haploid phase.

[1] Mather, K., *J. Genet.*, **41**, 159 (1941).

[2] Mather, K., and de Winton, D., *Ann. Bot.*, N.S. **5**, 297 (1941).

[3] Buller, A. H. R., *Bot. Rev.*, **7**, 335 (1941).

[4] Riley, H. P., *Genetics*, **21**, 24 (1936).

[5] Newton, D. E., *Ann. Bot.*, **40**, 105 (1926).

[6] Huttig, W., *Z. Bot.*, **24**, 529 (1931).

[7] Mather, K., unpublished.

HALLEY'S WORK AS A GEOGRAPHER

THE remarkable progress made in geography in the seventeenth and early eighteenth centuries owed much to a distinguished band of scholars at Oxford. This progress was made in two branches of the subject. On one hand, there was a large output of cosmographical works in which the authors, who were also teachers at Oxford, tried to present the rapidly growing geographical knowledge of the world. On the other hand, mathematicians developed that side of geography which was closely related to navigation. It was one of the duties of the Savilian professor of astronomy to deal particularly with this aspect of the subject, although in practice his colleague, the Savilian professor of geometry, seems to have been equally interested and active. Halley held the chair of geometry, and the more important part of his contribution to geography is attractively dealt with by Prof. S. Chapman in his paper "Edmund Halley as Physical Geographer and the Story of his Charts" (*Occasional Notes, Roy. Astron. Soc.*, No. 9, June, 1941).

In addition to the work described by Prof. Chapman, Halley contributed some geographical papers to the Oxford Philosophical Society, made a survey of the tides of the English Channel, and undertook a journey to the Adriatic Sea. He is, however, best known for his charts, and with these Prof. Chapman deals fully, illustrating his paper by some excellent reproductions and by three isogonic charts of different periods. He also disposes of the claim that Halley explained correctly the physical causes of the trade winds.

At the end of his paper, Prof. Chapman refers to the geographical inaccuracies of Halley's charts. These, as he points out, were "due mainly to the necessity to estimate longitude". Soon after Halley's maps were published, the cartographical researches of G. Delisle led to great improvements, while before he died John Harrison had invented the chronometer and so had made possible the accurate determination of longitude. Prof. Chapman also refers to certain "geographical curiosities" on Halley's maps, including the courses of certain rivers in Asia and Africa. It should be recalled that when Halley wrote there had been very little exploration of Asia and practically none of Africa. Geographers, in the case of the latter continent, had to rely largely on classical tradition and the work of Leo Africanus. How great was the ignorance and the fascination of the Dark Continent can be read in Defoe's story of the adventures of Captain Singleton.

Prof. Chapman's paper is timely in appearance, for the two hundredth anniversary of Halley's death is being commemorated this year. Halley held his Savilian chair until his death and did much to promote the study of applied geography. It is too much to say, as does the "Dictionary of National Biography", that he laid the foundation of physical geography but, none the less, his work was substantial and of lasting value: to it Prof. Chapman does full justice.

J. N. L. BAKER.

NOMENCLATURE OF *Cl. welchii* 'TOXINS' TYPE *A*

THE investigation of the toxins produced by *Cl. welchii* type *A* (classic gas gangrene of man) has led to the recognition of the complex nature of the soluble substances recovered from filtrates of cultures of this organism. The attempt to analyse these substances into their component elements has led to certain unfortunate confusions in the nomenclature, as pointed out by Llewellyn-Smith[1].

In view of the difficulties presented to research workers by this state of affairs, an informal meeting convened by Dr. M. Stephenson was held, under the chairmanship of Prof. T. Dalling of the Institute of Animal Pathology, Cambridge, at the Biochemical Laboratory in Cambridge on April 5, 1941, at which workers actively engaged in research in this field and those responsible for the production of antisera were present by invitation.

After a full discussion it was decided to adopt the following nomenclature as the basis for future publication.

(1) Among the antigenic substances found in filtrates the main toxic element is characterized by the following biological properties:

(*a*) It is lethal for mice when administered by intravenous injection.

(*b*) It produces a characteristic necrotic reaction on intradermal injection into guinea-pigs.

(*c*) It is hæmolytic *in vitro* for sheep red cells, the hæmolysin being oxygen-stable and requiring the presence of calcium ions for the full development of its action[2].

(*d*) It reacts specifically with normal human serum[3] and with egg-yolk solution to give a characteristic turbidity[2].

This reaction also requires the presence of calcium ions and is probably due to the action of a lecithinase which splits phosphocholine from lecithin[4].

These various reactions appear to be due to the action of one substance designated as the *alpha toxin* and they can be neutralized by alpha antitoxin.

The *alpha* toxin has long been recognized as the main element in the pathogenic action of *Cl. welchii* type *A*[5].

(2) A second hæmolysin has been recognized in *Cl. welchii* filtrates which has properties distinct from those of the *alpha* toxin :

(*a*) It exhibits a slight but irregular action when administered intravenously to mice, owing to the presence of natural antitoxin in this and other experimental animals.

(*b*) It produces a hæmorrhagic reaction, but it is not necrotic in action on intradermal injection into guinea-pigs.

(*c*) It is hæmolytic for sheep red cells *in vitro* ; the hæmolysin is reversibly oxidizable, the hæmolytic activity declining with the ageing of filtrates ; the hæmolysis is independent of the action of calcium ions.

(*d*) It does not give a reaction with human serum or egg yolk solution.

(*e*) It resembles closely streptolysin O.

(*f*) The reactions produced by this second hæmolysin are neutralized by high titre antihæmolysin O as well as by the homologous antiserum.

It was agreed that this second hæmolysin should be designated as *theta hæmolysin*, and that it should be clearly recognized as being distinct from *alpha* toxin of *Cl. welchii.*

The first mention of this type of hæmolysis is made by Neill[6] but no special nomenclature was adopted. Prigge erroneously called this hæmolysin *alpha*[7] and this mistake was repeated in the League of Nations Bulletin of the Health Organisation (8, 797 ; 1939).

The letter theta was first used as a designation for this hæmolysin in the literature by Macfarlane, Oakley and Anderson[2], and its properties have been clearly defined by Todd[8].

The use of zeta[7] for what is obviously the alpha toxin is therefore discarded according to the ordinary usages of nomenclature.

No assumption is made that these two elements are the only 'toxins' present in filtrates from all strains of *Cl. welchii*, type *A*.

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[1] NATURE, **147**, 87 (1941).

[2] Macfarlane, Oakley and Anderson, *J. Path. and Bact.*, **52**, 99 (1941) ; van Heyningen, 1941, about to be published.

[3] Nagler, *Brit. J. Exp. Path.*, **20**, 473 (1939).

[4] Macfarlane and Knight, *Biochem. J.*, **35**, 884 (1941).

[5] Glenny, Barr, Llewellyn-Jones, Dalling and Ross, *J. Path. and Bact.*, **37**, 53 (1933).

[6] *J. Exp. Med.*, **44**, 199, 215, 217 (1926).

[7] *Z. Immunitätsforsch.*, **91**, 457 (1937).

[8] *Brit. J. Exp. Path.*, **22**, 172 (1941).

RECENT WORK ON THE GEPHYREA*

DR. A. C. STEPHEN has published two memoirs relating to this group. He had a difficult task before him, for it is well known that its members are extremely elusive owing to their habitat and that the few specimens usually available are frequently damaged—a fact borne out by a species sometimes only being represented by an isolated introvert or flattened skin. It is therefore specially to be appreciated that so many specimens were brought up whole and undamaged and that colour notes made at the time of capture are available. The Discovery species are mainly from southern waters but some of the Sipunculids were secured in the Atlantic on the outward and homeward runs. Only one species is recorded in both reports—*Pyscosoma nigrescens* Keferstein, a widely distributed form in tropical waters, now obtained for the first time from Ascension and Tristan da Cunha. There are two new species from deep water from the Gulf of Oman and off the Maldive Islands, and one from the Gulf of Aden ; also one new species of Thalassema from the Antarctic. The most interesting records, however, are those relating to bipolar species.

It has been known for some time that there is a close similarity, amounting in many cases to specific identity, between arctic and antarctic species belonging to the Echiuridæ, Sipunculidæ and Priapulidæ, and this is further exemplified in the Discovery collections. Of the twenty-three species known from the Antarctic and here listed (a few obviously warm-water forms being excluded from the list) half are either northern species or very closely related to them and ten of these are identical with, or regarded as varieties of, arctic species, and two are very closely related to arctic forms but are still regarded as specifically distinct. In this list species collected by the British, Australian and New Zealand Antarctic Research Expedition are included, the report of which by the same author is now in the press. Of the ten which are identical with, or regarded as varieties of, arctic species, four are included in the Discovery Collections.

The author directs attention to the fact, which stands out and may represent a real condition, that in the Antarctic most of the bipolar species seem to be confined to the South American quadrant.

The known range of distribution in several cases has been considerably extended, thanks to the wide area over which investigations were conducted by the Discovery ships. The Echiurids especially are interesting. Only three species of this group were known from the Antarctic. Now three species are added, two of which, *Hamingia arctica* and *Thalassema faex*, are well-known species which have not so far been found in other than Northern seas, and the third is a new species, *Thalassema arcticum.*

Both monographs are illustrated by good photographs.

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* The Echiuridæ, Sipunculidæ and Priapulidæ collected by the Ships of the Discovery Committee during the Years 1926 to 1937, by A. C. Stephen, D.Sc. Discovery Reports, Vol. 21, pp. 235–60, Plates VII, VIII. 1941. Issued by the Discovery Committee, Colonial Office, London, on behalf of the Government of the Dependencies of the Falkland Islands (Cambridge University Press). Sipunculids and Echiurids of the John Murray Expedition to the Red Sea and Indian Ocean, 1933–34, by A. C. Stephen, D.Sc., John Murray Expedition, 1933–34. Scientific Reports, Vol. 7, No. 4, 1941. (British Museum (Natural History), London.)

FORTHCOMING EVENTS

Saturday, January 10

British Institution of Radio Engineers (at the Federation of British Industries, 21 Tothill Street, London, S.W.1), at 3 p.m.—Dr. W. Wilson: "Recent Developments in the Design and Application of the Cathode Ray Oscillograph".

Monday, January 12

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 3 p.m.—Discussion on "Geographical Aspects of Regional Planning".

Wednesday, January 14

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. F. Armstrong, F.R.S.: "The Post-War Home—its Interior and Equipment". 3: "Materials, Old and New".

Friday, January 16

Royal Society of Arts (India and Burma Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Bryce Burt: "Agricultural Progress in India during the Decade 1929–39".

Saturday, January 10—Sunday, January 11

Association of Scientific Workers (at Caxton Hall, Westminster, London, S.W.1). Conference on "Science and the War Effort".

Saturday

10 a.m.—Opening Address by Sir A. Daniel Hall, K.C.B., F.R.S.

10.30 a.m.—"University Training of Scientists". Dr. W. A. Wooster (Chairman), Prof. J. A. Carroll, Dr. V. E. Cosslett, Mr. R. R. Siday, Mr. D. G. Arnott.

10.30 a.m.—"Building, Housing and A.R.P." Mr. Ove N. Arup (Chairman), Dr. R. Fitzmaurice, Miss J. M. Blanco White.

2 p.m.—"Training of Technical Personnel". Mr. E. G. Savage (Chairman), Mr. J. A. Lauwerys, Dr. E. A. Rudge, Mr. D. A. Bell, Dr. B. E. Gilbey.

2 p.m.—"Food and Agriculture" (1st Session). Sir John Russell, F.R.S. (Chairman), Sir John Orr, F.R.S., Sir A. Daniel Hall, K.C.B., F.R.S., Dr. H. M. Sinclair, Prof. H. D. Kay, Prof. F. G. Gregory, Dr. A. Walton.

4.30 p.m.—"Food and Agriculture" (2nd Session). Discussion.

Sunday

10 a.m.—"Utilisation of Scientific Personnel". Prof. S. Chapman, F.R.S. (Chairman), Prof. W. Wardlaw, Mr. E. D. Swann, Prof. H. Levy, F.R.S., Mr. D. P. Riley, Mr. F. M. H. Markham.

2 p.m.—"Application of Scientific Knowledge to Production and Services Problems". Prof. J. D. Bernal, F.R.S. (Chairman), Mr. T. Halse, Dr. P. Garland, Dr. K. Mendelssohn, Mr. J. W. Myers, Dr. J. Kuczynski, Mr. J. L. Pinder.

4.30 p.m.—Final Discussion. Mr. J. A. Henley, Prof. J. D. Bernal, F.R.S.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Dietitian in charge of the Dietetic Department—The House Governor and Secretary, General Infirmary, Leeds (January 20).

Lecturer in Mechanical Engineering—The Principal, South-West Essex Technical College, Forest Road, Walthamstow, London, E.17.

Executive Engineers by the Nigerian Government Public Works Department—The Central Register (E.364), Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, London, S.W.1.

Assistant Engineer by the Sierra Leone Government Railway—The Central Register (E.365), Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, London, S.W.1.

Engineer by the Sierra Leone Government Public Works Department—The Central Register (E.372), Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, London, S.W.1.

Psychologist (man) at the Sutton L.C.C. Hospital, Sutton—The Medical Officer of Health (B), Mental Health Services, West Park Hospital, Epsom, Surrey.

Professor of Physiology—The Secretary, University College, Cork.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Research Reports of the British Non-Ferrous Metals Research Association. Association Series No. 562: Researches on the Structure of Alloys. By Dr. W. Hume-Rothery. Pp. 20. (London: British Non-Ferrous Metals Research Association.) 2*s*. 6*d*. [1012

List of Fossil Plants found in the Coal-Bore made at Washing Bay, Co. Tyrone, in 1918; with Short Descriptions of New Species. Collected, identified and given to the National Museum of Ireland by Dr. T. Johnson. Pp. 13. (Dublin: National Museum.) [1212

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. War Food Production Advisory Bulletin No. 6: Cereal Production. By E. T. Jones. Pp. 46. (Aberystwyth: Welsh Plant Breeding Station.) 1*s*. [1212

Other Countries

Forest Bulletin No. 92: The Testing of Packing Cases for Army Boots and Suggested Improvements in their Design. By V. D. Limaye. Pp. iii+7+3 plates. 6 annas; 7*d*. Forest Bulletin No. 93: Indian Timbers for Tool Helves and Handles. By V. D. Limaye. Pp. iii+8+2 plates. 5 annas; 6*d*. (Delhi: Manager of Publications.) [412

Ceylon. Part 4: Education, Science and Art (D). Administration Report of the Acting Director of Agriculture for 1940. By E. Rodrigo. Pp. D18. (Colombo: Government Record Office.) 30 cents. [412

Records of the Geological Survey of India. Vol. 76, Bulletins of Economic Minerals No. 4: Phosphates. By M. S. Krishnan. Pp. 38+1 plate. (Calcutta: Geological Survey of India.) 12 annas; 1*s*. [512

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 41: Fertilizer Experiments on Sugarcane in India, 1932–39. By Dr. R. D. Edge. Pp. 64+1 plate. 3 rupees; 5*s*. Miscellaneous Bulletin No. 42: Fruit Pests of Baluchistan. By Nazeer Ahmed Janjua and C. K. Samuel. Pp. 42+3 plates. 2 rupees; 3*s*. (Delhi: Manager of Publications.) [512

Report of the Kodaikanal Observatory for the Year 1940. Pp. 4. (Delhi: Manager of Publications.) 2 annas; 3*d*. [512

Annual Report of the Agricultural Meteorology Section, India Meteorological Department, for the Year 1939–40. Pp. vi+38. (Simla: Government of India Press.) [512

Dominion of Canada. Report of the Department of Mines and Resources including Report of Soldier Settlement of Canada for the Fiscal Year ended March 31, 1941. Pp. 244. (Ottawa: King's Printer.) 50 cents. [1012

Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 7, No. 10: Radial Velocities and Spectral Line Intensities for Iota Herculis. By R. M. Petrie and William Petrie. Pp. 189–198. Vol. 7, No. 11: The Spectrographic Orbital Elements of H.D.23277. By R. M. Petrie. Pp. 199–204. (Victoria, B.C.: Dominion Astrophysical Observatory.) [1012

Nyasaland Protectorate: Geological Survey Department: Colonial Development. Water Supply Investigation Progress Report (No. 10) for the Year 1940. Pp. 8. (Zomba: Government Printer.) 1*s*. [1112

Annual Report of the Haffkine Institute for 1939. By Lt.-Col. S. S. Sokhey. Pp. iii+94. (Bombay: Government Printing and Stationery Office; London: High Commissioner for India.) 4 annas; 5*d*. [1212

Union of South Africa: Department of Agriculture and Forestry. Science Bulletin No. 232 (Chemistry Series No. 166): Dinitro-Ortho-Cresol and other Insecticides as Locust Poisons; Experiments of 1938–39. By M. C. A. Nolte. Pp. 55. 6*d*. Chemistry Series No. 167: Chrome Ores of the Western Bushveld Complex. By Dr. C. F. J. van der Walt. (Reprinted from "Transactions of the Geological Society of South Africa", Vol. 44, 1941.) Pp. 34. (Pretoria: Government Printing and Stationery Office.) [1612

Report of the Aeronautical Research Institute, Tokyô Imperial University. No. 212: The Coupling of the Propeller Blade Bending Vibration with the Crankshaft Twisting Vibration of a V Type Engine. By K. Tanaka and T. Ohino. Pp. 43. (Tôkyô: Kôgyô Tosho Kabushiki Kaisha.) 95 sen. [1612

Indian Central Jute Committee. Technological Research Memoir No. 3: The Moisture Regain of Jute at a Range of Atmospheric Humidities. By C. R. Nodder, K. R. Sen and B. K. Chakrabarti. Pp. 10. (Calcutta: Indian Central Jute Committee.) 1 rupee; 2*s*. [1612

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 45: Investigations on the Cold Storage of Potatoes. By Dr. D. V. Karmarkar and B. M. Joshi. Pp. 22. (Delhi: Manager of Publications.) 1 rupee; 1*s*. 6*d*. [1612

Report of the King Institute of Preventive Medicine, Guindy, for the Year ending 30th September 1940, by Lt.-Col. H. E. Shortt; and Report of the Government Analyst, Madras, by Herbert Hawley. Pp. 73+3. (Madras: Government Press.) 8 annas. [1612

Josiah Macy, Jr. Foundation. A Review by the President of Activities for the Four Years ended December 31, 1940, with Extracts from the Treasurer's Report for the Years 1937–1940. Pp. 125. (New York: Josiah Macy, Jr. Foundation.) [1612

Journal of the Indian Institute of Science. Vol. 23 A, Part 11: On a New Method of Synthesis of Phenanthrene Derivatives. By P. C. Guha and S. Krishnamurthy. Pp. 183–190. 12 annas. Vol. 23A, Part 12: Synthetical Experiments in the Camphane Series, Part 6: Synthesis of Homocamphoronic Acid. By P. C. Guha, K. S. Subramaniam and V. R. Srinivasan. Pp. 191–200. 14 annas. Vol. 23A, Part 13: On Utilisation of Indian Turpentine Oils. Part 1: The Constituents of Turpentine Oil from *Pinus longifolia* Roxb., *Pinus excelsa*, *Pinus khasya* and *Pinus merkussi*; Part 2: Conversion of α- and β- Pinenes into Bornyl Acetate by Acetic Acid in Presence of Catalysts; Part 3 (i) Catalytic Isomerisation of α- Pinene and β- Pinene to Comphene, (ii) Synthesis of Camphor from Pinene-Camphene Misture. By P. C. Guha and Arunendra Narayan Roy. Pp. 201–226. 1.12 rupees. Vol. 23A, Part 14: Activation and Clarifying Properties of Fuller's Earth Part 7: Activation of Fuller's Earth. By B. S. Kulkarni and S. K. K. Jatkar. Pp. 227–236. 12 annas. (Bangalore: Indian Institute of Science.) [1612

Annual Report of the Public Health Commissioner with the Government of India for 1940. Pp. vi+110. (Delhi: Manager of Publications.) 12 annas; 1*s*. [161

Bulletin of the American Museum of Natural History. Vol. 78 Art. 6: The Morphological and Functional Evolution of the Tarsu in Amphibians and Reptiles. By Bobb Schaeffer. Pp. 395–472. Vol 78, Art. 7: On a Collection of Millipedes and Centipedes from North eastern Peru. By Ralph V. Chamberlin. Pp. 473–536. (New York American Museum of Natural History.) [161

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THE UNIVERSITY OF ORISSA

DURING the first decade of this century, mainly as the result of the recommendations of the Curzon Commission culminating in the Universities Act of 1904, the older Indian universities, Madras, Bombay, Calcutta and the Punjab, modified their examination requirements and effected fundamental alterations in the teaching in their affiliated colleges. Unfortunately, the university examinations in their various grades from the matriculation upwards continued to be recognized as qualifications for admission to the various Civil Services, since only for a few appointments, such as those in the Finance Department, was there a special Civil Service examination. The linking of the Civil Services with the universities has had the unfortunate result of overcrowding the colleges with students, in many cases of mediocre ability, and has so to some extent nullified the beneficial effect of the improved courses of study. Two other factors have also contributed to still further overcrowding : first, the continued though welcome spread of primary and secondary education, and secondly, the increasing desire for a training in the methods of science.

This increasing demand for higher education has resulted in the opening of a large number of new institutions of university rank throughout the Indian Empire. Unlike the older federal universities, the majority of these new universities have been of the unitary teaching type, as exemplified in the University of Lucknow. At the same time, the older universities have in all cases made themselves directly responsible for much of the post-graduate teaching.

In 1938 the Government of Orissa recognized the necessity of reorganizing the higher education in the Province, and it appointed a representative committee under the chairmanship of Pandit Nilkantha Das to examine the question of establishing a university in the Province. This committee presented its report* last June, and it unanimously recommends that a university of a modified affiliating type should be established. It is suggested that the university should in the first instance be purely affiliating, but that it should later be responsible for the post-graduate teaching. The administrative structure recommended for the new university is very similar to that of the University of Madras.

While many may regard it as somewhat retrograde to establish a new university of the affiliating type, it must be borne in mind that Orissa is a small and not too well-endowed province. The principal college of university standing is the Ravenshaw College at Cuttack, and this will be the nucleus of the teaching university. It would, however, scarcely be economic if the teaching centres at Parlakimedi and Berhampur were to be closed down. From the figures given in the Committee's report, it is clearly not anticipated that the number of university students will be large, the estimated size of the intermediate classes in arts and science combined being about 400 students, and although there is to be a Faculty of Law, there is no provision for the teaching of medicine. It is refreshing to note that the Committee recognizes that teaching is not the sole function of a university, but that facilities should also be available for original work both in arts and science. It is not unnatural that the Committee should recommend that the post-graduate teaching in Oriya history, language and literature should receive special consideration. We trust that the new university will soon be opened and be making its own contribution to learning.

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* Supplement to the *Orissa Gazette*, July 4, 1941.

ORIGIN OF LANDSCAPE FEATURES

Landscape

As Developed by the Processes of Normal Erosion. By Prof. C. A. Cotton. Pp. xviii + 302 + 45 plates. (Cambridge: At the University Press, 1941.) 21*s*. net.

WITHIN the last two decades there has been in Britain a marked revival of interest in the study of landscape features. The subject of geomorphology, even in its more limited scope as applied to the understanding of the surface features of the earth, has attracted new workers both from the fields of geology and geography, and fresh methods of investigation have been devised. The study of erosional geomorphology represents perhaps the most important common ground between geology and geography. In the past geologists have varied in the emphasis which they have laid on the study of 'physical geography', but until recently they have treated it mainly as part of an introductory course; lately there has been a greater tendency to regard it as representing a more important branch of that subject, and to recognize that future progress in the investigation of landscape must depend on workers whose geological training has brought them some acquaintance with the methods of investigation needed for these fields of inquiry.

Prof. Cotton, who has written this latest volume on landscape features and their origin, is in no doubt as to the place of this study. "Notwithstanding the close relation of the study and description of the natural landscape to geography", he trusts that geologists will accept this account "of the elementary principles of geomorphology as a contribution to the literature of their science". For he stresses the fact that the development of land forms has followed as a corollary of earlier geological events, while an understanding of geomorphic processes is essential for the interpretation of geological history. It may perhaps also be added that a real appreciation of the geological time-scale is necessary if landscape features are to be understood and correctly related to one another.

In this volume Prof. Cotton has not attempted to cover the whole field of land forms: he has limited himself to those features developed by the processes of "normal erosion". This he takes to include the results of atmospheric weathering (predominantly chemical) combined with downhill transportation of rock debris, mainly by rain and running water. These processes develop 'normal' landscapes. He regards as special agencies those which depend on climate, whether arid or glacial, and on marine erosion, the effects of which are confined to the land margins. While this limitation enables the author to deal more adequately with the processes which have modified the earth's surface over the widest areas, it has some disadvantages, for since the development of the present land surfaces began there have been great changes in the distribution of climatic regions, and it would be impossible to describe the landscape features of many regions, especially in the northern hemisphere, in terms of normal erosion. This is, of course, fully recognized by the author, and he has found himself compelled to refer to some of the features due to more special agencies.

Geomorphologists owe a great deal to three American pioneers, Gilbert, Powell and W. M. Davis; Prof. Cotton acknowledges this indebtedness not merely by the dedication of his book to their memory, but also by many references to their work and opinions. This must not be taken to imply that the book is formal, or lacks up-to-date references: it presents an original and comprehensive account of the results of normal erosion, differing in outlook and emphasis from other books of similar scope, and dealing with the landscape of regions in all parts of the world.

Probably this wide choice of less familiar examples will be one of the most fruitful features of this volume, particularly since the illustrations lend such a distinction to the writing. For Prof. Cotton has supplied more than two hundred text-figures; most of them are new and many are beyond praise. His 'block-diagrams' are particularly successful, and convey the relation between structure and surface features in a way that will stimulate the geological student and will make the book doubly useful to those untrained in structural work. But these admirable figures do not exhaust the illustrations provided, for there are also forty-five plates, most of them with two photographs, showing a wide range of features; these are chosen from all parts of the world, and their value is increased by the inclusion of many original views of New Zealand.

The sequence of chapters is somewhat unusual: after an early chapter on mass movement of waste there is a study of rivers, their deposits and related phenomena, which occupies fourteen chapters. Then comes a chapter on peneplains and one on resurrected fossil land surfaces. Two chapters on the effects of uplift and warping and the movement of base-level are followed by three very interesting chapters on fault features, block-faulted landscapes, and fault scarps, the book concluding with a short account of limestone landscapes.

In view of recent discussions, British geomorphologists will turn with particular interest to the chapter on peneplains, where the old-age stage of the cycle of erosion is discussed and illustrated. A somewhat fuller treatment of the peneplain problem would have been acceptable. If, as is generally agreed, many areas present us with a stage in the dissection of an uplifted erosion surface, it may be suggested that the study of such surfaces and their relics is of fundamental importance. It is interesting, however, to read of W. M. Davis' explanation of the limiting steepness of the slopes on a peneplain, given a quarter of a century ago: the slopes were such that one might lay out a straight road on the peneplain in any direction, "and trot on it". In these days, comments Prof. Cotton, this would be a 'high-gear' road. He gives British workers some notion of perspective, perhaps, by limiting his reference to British peneplains to some five lines and three footnotes: since so many problems are presented by the erosion surfaces of this small region, notwithstanding the many investigators, it may be felt that some caution is advisable in interpreting some larger and less accessible peneplains.

The production of such an elegant volume, attractively illustrated and on admirable paper, at this time, with the author resident in New Zealand, calls for the warmest congratulations both to him and to the Cambridge University Press. The publication is the more noteworthy since the volume deals with matters of which most must long remain within the province of 'pure' science. The book may be strongly recommended for reading by students of geology and geography, and it should find a place in the libraries of universities and schools.

A. E. TRUEMAN.

TEACHING OF PHYSIOLOGY

Starling's Principles of Human Physiology

Eighth edition, edited and revised by Prof. C. Lovatt Evans; the chapters on the Special Senses revised by Prof. H. Hartridge. Pp. x + 1247. (London: J. and A. Churchill, Ltd., 1941.) 32*s*.

Physiology for Pharmaceutical Students

By Dr. Harold Hayden Barber. Second edition. Pp. x + 526. (London: Baillière, Tindall and Cox, 1941.) 15*s*.

STARLING'S "Principles" first appeared a generation ago, and throughout the intervening years it has been the main vehicle for the diffusion of trustworthy and co-ordinated physiological knowledge throughout the English-reading world. Since Prof. Lovatt Evans has been in charge of the work, it has retained the full treatment of the chemical and physical basis of physiology for which the earlier editions were noteworthy; he has dealt more fully with problems of integration and has kept well abreast of contemporary developments, which are presented in a lucid and balanced manner and with adequate, but not superfluous, documentation.

In the current eighth edition, the physiology of the central nervous system has been completely rewritten to incorporate recent advances such as those dealing with the intricacies of nervous transmission in the spinal cord, and to convey generally the current attitude; newer work in such active fields as the endocrines, vitamins, urinary secretion and metabolism is fully considered. The sections on reproduction and on the special senses (the latter written by Prof. H. Hartridge) are especially noteworthy.

The book, however, is still growing in size, and Prof. Evans will soon have to face the problem which many American writers feel they can safely ignore, whether there is not an optimum size which should not be exceeded for a standard text-book. Most books are written to serve an audience, and texts on human physiology are mainly read by students and practitioners of medicine who want a survey of the subject which can be studied and mastered in the limited time at their disposal. Physiology and the related sciences are expanding at a great rate; before the War, some ten thousand papers appeared annually, which contained new contributions great or small. The author of the standard text-book has the arduous responsibility of sifting this work, of incorporating the outstanding advances, of conveying the changing outlook of his subject, and of directing attention to the chief growing points and to the guiding generalizations which are emerging.

But this does not exhaust the list of the text-book writer's responsibilities; it is still a matter for dispute whether medicine is a science or an art, but undoubtedly the practitioner of medicine must be a man of science as well as an artist. It is essential therefore that at some stage in his education he should be given a sound grounding in the methods and outlook of science. The physiologist may be forgiven for saying that no other subject in the medical curriculum is better adapted than his own for such a high purpose. Enough time is available in the course to deal with some aspects of the subject in sufficient detail to show their historical development. Rigid experimental and observational proofs can be described and carried out in the laboratory of the main theses of the subject. The student may be shown how experiments are planned and carried out and how conclusions are drawn. It may be stated without offence that a good physiological course will make a medical man passably immune to the pitfalls of loose thinking and to the acceptance of inadequately confirmed claims. In addition, however, physiology is one of the principal limbs of the tripod on which clinical medicine rests. Much of the evidence on which human physiology draws is derived from observations and experiments on patients, and to that extent physiology is none other than medicine.

If the text-book is to be kept within manageable limits, the author will not attempt to summarize, ever more briefly, unintelligibly and uninterestingly, the ever-growing mass of material with which he is confronted. He will select his material with the aim of giving the basis of the scientific training, of presenting adequately the fundamental facts and principles of his subject, and he will enlarge especially on aspects of vocational value to the medical practitioner. Observations on man which are scientifically satisfactory must replace increasingly observations made on the lower animals. When human material is inadequate, stress will be laid on observations made on the higher animals. One can see these tendencies now in the treatment of such problems as control of respiration, erythropoiesis, muscular exercise, functions of the higher levels of the brain, secretion of urine, nutrition, and metabolism, to select but a few examples at random. As Prof. A. V. Hill has remarked, teaching is an experimental science, and the abilities of authors will be taxed to the full in the future if their writings are to prove of maximum advantage to the reader.

Dr. Barber's book is obviously meeting a need, as a second edition has been called for in four years. It resembles closely in content and treatment the smaller physiological manuals intended for medical students, except that the nervous system is dealt with very briefly, the special senses are omitted, diet and metabolism are touched on lightly, though a relatively detailed account is given of the vitamins and endocrines. There is also a short section on the elementary pharmacology of some special substances.

Physiology forms part of the course of instruction and of the examination for the elementary qualification for chemists and druggists and for the higher qualification of pharmaceutical chemist. One and two years respectively are allotted for the study of pharmaceutical chemistry, pharmacognosy, pharmaceutics, forensic pharmacy and physiology. As the time available for physiology even in the longer course is very limited, one supposes that physiology has been introduced into the curriculum (especially in the shorter course) mainly for cultural reasons. It is proper that a man who will deal with the preparation and marketing of remedies for human ills should have some general idea of the working of the human body. The physiological training is not vocational because the pharmacist should have few if any opportunities of making practical use of his physiological knowledge, unless he allocates to himself the function of an immature healer and adviser on minor maladies.

Though Dr. Barber's book is so full of facts and figures, chemical reactions and experiments, it does not seem to give the elementary student who is pressed for time a co-ordinated simple account of the workings of the human body. Inadequate attention is devoted to explaining fully and carefully the fundamental principles of the subject. These failings are probably the result in large measure of the existence of a rigid examination syllabus for this group of students, which if it were followed conscientiously by teachers in planning their lectures would make their course no better than a caricature. Thus the 1927 syllabus for the elementary qualification of chemist and druggist refers specifically to "properties of cardiac, striated and unstriated muscle, the mechanism of the heart valves, the coronary circulation, the effect of inflow and rate on the output of the heart, the importance of the maintenance of the blood pressure". There are references to blood, glands of internal secretion, the alimentary tract and food, but so far as this syllabus is concerned the body would appear to possess, among others, no respiratory system, no nervous system, no sense organs, no kidney and no urine. By 1941 the syllabus had gained references to the principles underlying biological assay, but in the meantime the body had specifically lost the anterior pituitary, parathyroids and the organs of reproduction.

It is difficult to say what useful purpose a syllabus of this singularly unbalanced character can serve. In the universities it will no doubt be ignored and a general elementary course based on cultural consideration will be given. In the many less experienced centres that train students of pharmacy, attempts may be made to use the examination syllabus as a basis of teaching, with the result that the course in physiology will be of negligible value. The student reading for the qualification of pharmaceutical chemist needs no special manual, and could safely be entrusted with the shorter works intended for medical students. The more elementary student needs a really straightforward and fully explanatory work which will enable him to see the workings of the body in outline and as a co-ordinated whole. If the present syllabus in physiology for elementary students of pharmacy were completely jettisoned, a considerable advance would be made in the proper training of such students.

SAMSON WRIGHT.

IMPACT OF INVENTIONS ON PEOPLE

Technology and Society

The Influence of Machines in the United States. By S. McKee Rosen and Laura Rosen. Pp. xiv + 474. (New York: The Macmillan Company, 1941.) 12*s.* 6*d.* net.

WE are repeatedly told by those who look beyond the passing events chronicled from day to day that the structure of human society is changing with a rapidity hitherto unimagined, that the world after the War will be a completely different world from that which we knew before. In this there is probably a large measure of truth, but though the War has undoubtedly speeded up the rate of change, the change was inevitable for other reasons. It is explained by the march of technological invention. 'March' seems an inadequate word to describe what has taken place during the brief lifetime of the present older generation—it is rather a flight which leaves one breathless. There is no more ruthless, but—if wisely directed—ultimately beneficent iconoclast than invention, no more powerful lever for moving nations out of the deep ruts of habit and convention into which, if left lethargic, they tend to sink. We are being so lifted and shaken now, and it is as well to realize what is happening if we are to profit by the experience.

In spite of its somewhat deterrent title to those who are not mechanically minded, anyone unfamiliar with the less common inventions of recent times will gain much useful information by studying this book: it is both readable and stimulating. In an introductory chapter Prof. W. F. Ogburn gives an admirable summary of modern discoveries, stressing the imperative need for a national policy wisely shaped in the light of their probable future trends. Naturally he has the United States in mind, but the lesson is one we also might well learn. Attention is directed to the amazing advance of science since the beginning of the century as illustrated by six industries in which development has been great, based upon the invention of the telephone, motor-car, aeroplane, motion picture, rayon and radio. He recalls that round about 1900 Theodore Roosevelt was commended for "his characteristic courage" upon riding in an automobile; forty years later there is one car to every five persons in the States. In 1903 a distinguished American man of science went so far as to surmise that mechanicians would be "ultimately forced to admit that aerial flight is one of that great class of problems with which men can never hope to cope". One particular group of comparatively modern inventions deserves note, although it has been regarded by the authors, no doubt justifiably, as outside their domain: it only receives passing mention. Devices for controlling conception are gradually being perfected. The conspicuous effect of these discoveries, for better or worse, on the trend of world population is now generally recognized, and they are perhaps destined radically to influence family life, the very texture of civilized society.

A major achievement of modern technology is the possibility of continuous production, but such continuity is profitless if there is no effective demand which can be equated to the supply of goods produced. For demand to be effective wages and prices must be suitably related, and here the Government, by its ultimate control over the creation of credit and the conditions of labour, has a responsible part to play. This aspect of the problem is not discussed by the authors. They do, however, point out that machine production, though it involves an initial displacement of labour, should eventually make possible a big increase in sales by reduction in price, and so result in a net gain in employment. Electric light and power, the manufacture of cars, and newspaper publishing are cited as industries where this has actually happened. But everybody does not benefit. Figures are quoted showing that, while annual production per man rose by 39 per cent in the United States between 1920 and 1935, the index of employment fell by 18 per cent. This dilemma could be partly met by continued education, earlier retirement for the elderly, and increased leisure for all, in preference to enforced total idleness for so many. Because such a solution has not yet been adopted, the progress of invention is frequently regarded by the workers with dread. Instead of raising their standard of living, as it should do, it condemns a considerable number to a bare maintenance on charity or the dole. Nor is it only the wage-earner who stands to suffer. We read of company managers who, fearing the adoption of new machines by their trade rivals, do their best to block the marketing of improved models. Commercial competition is not always in the public interest, as is revealed also by the story of national broadcasting in the United States.

But here again there are signs of improvement. Among thinking people there is a steadily growing realization of the essential interdependence of all sectional interests, both within the State and in the wider world. Selfish individualism must give way to "the idea of the general welfare as the basis of public policy." To put this principle into practice demands a sensitive handling of groups, which unfortunately is comparatively rare. In this connexion the description given of the development of the Tennessee Valley Authority is instructive. Created by Congress in 1933 as a public corporation, it possessed at the same time the flexibility and initiative of a private enterprise. Its function was to plan and develop the Tennessee Valley, and its express policy was to use existing agencies wherever possible. The resulting growth of "inter-governmental co-operation attuned to regional needs" is said to have been most impressive. It is clear that success in this case was largely due to appreciation of the importance of the right psychological approach to the various bodies concerned. If we go to work along similar lines, in Great Britain as in the United States, there should be good hope for the future.

D. Caradog Jones.

NEUROLOGY FOR STUDENTS AND PRACTITIONERS

Diseases of the Nervous System

Described for Practitioners and Students. By Dr. F. M. R. Walshe. Second edition. Pp. xvi + 325. (Edinburgh: E. and S. Livingstone, 1941.) 12*s*. 6*d*. net.

THE first edition of this book appeared in September 1940, and the fact that a second edition has been needed within a year (this edition was published in August) speaks for itself. Dr. Walshe planned this book for the use of practitioners and medical students; and there can be no doubt that he has been entirely successful in his object. The need of just such a book as this has been long felt by those engaged in teaching students the fundamental elements of neurology, and those of us who are familiar with Dr. Walshe's powers of lucid exposition and his critical faculty will not be surprised by his success.

Though some important additions have been made in the present edition, the book has retained its original character and purpose. The additions consist of some thirty or so pages and a number of excellent photographs and diagrams which have added materially to the usefulness of the book.

The book is planned in two parts, the first dealing with the fundamental groundwork involved in the correlation of observed physical signs and symptoms, with their physiological and anatomical counterparts, the second being devoted to a descriptive account of the more common diseases of the nervous system. The additions to the first part consist of a brief statement of the tissue reactions occurring in nervous diseases, and some amplification of the section dealing with the organization and symptomatology of sensory, visual and speech functions.

In Part 2 the chapter on intracranial tumours has been partly recast, and additions have been made to the chapters on acute infections, injuries to the head and spine, and lesions of the spinal nerves.

In the preface to the first edition, Dr. Walshe emphasizes the fact that he has written a book which shall deal only with what is possible in general practice, and so warns the reader that he will find little about such things as ventriculograms or of the electro-encephalogram—as the general practitioner will not be required to make or interpret either. That is no doubt true at the present time, but I think that in a future edition for which, if I am not mistaken, there will be a demand before very long, a short chapter on the possible usefulness particularly of the electro-encephalogram might be added with advantage. Mention, too, might be made of the dramatic success which sometimes follows the use of deep X-ray therapy in some cases of post-herpetic neuralgia, not only of spinal type also in some cases where the Gasserian ganglion has been involved. Rather fuller description might with advantage be added to the clinical picture of severe head injuries and to their treatment, for this is a subject of common occurrence and the cause of much anxiety to practitioners and friends alike.

Dr. Walshe has included in his book a chapter on the psychoneuroses, dealing mainly with their diagnosis. In the preface to the first edition he has commented on this in phraseology so apt that I feel I must quote him here: "It may appear unduly sanguine to hope to give within the compass of a single chapter a useful account of this very important aspect of medicine when we recall what a vast literature has grown up around it in the present century. However, much of this is concerned with hypothesis, and the essential task of diagnosis, the clinician's first task, has usually been a Cinderella at this carnival of literary expansiveness." In this chapter is contained a note on so-called 'traumatic' neurosis, a subject on which, as the author says, a candid statement is long overdue. I do not remember seeing in any other text-book of neurology any emphasis laid on the fact that trauma *per se* does *not* cause neurosis. Judging from a considerable experience in courts of law, it would seem that judges, lawyers and medical men giving evidence think that 'traumatic' neurasthenia is as much an entity as measles. It is high time that they became better instructed.

Useful chapters are included in the book on bromide intoxication (a condition which is so often unrecognized) and some general observations upon the treatment of nervous disorders in which what can and what cannot be hoped for are candidly set out. The book ends with an excellent and simple scheme for the examination of the nervous system.

I can recommend the book to the student and practitioner alike in the sure confidence that they will both profit from a study of it and also obtain considerable pleasure in the process.

C. M. HINDS HOWELL.

THE STUDY OF LYMPH

Lymphatics, Lymph and Lymphoid Tissue

Their Physiological and Clinical Significance. By Prof. Cecil Kent Drinker and Dr. Joseph Mendel Yoffey. (Harvard University Monographs in Medicine and Public Health, No. 2.) Pp. x+406. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941.) 4 dollars.

THIS book is good reading since it shakes convictions and stifles beliefs; and, exposing our ignorance, it will stimulate research. The first chapter is coldly anatomical, but warm argument soon begins. In the second chapter, the authors have to consider the permeability of capillaries in order to account for the composition of tissue fluids and lymph. Here there is difficulty with the albumins and globulins often present in lymph: it is agreed that they are derived from the plasma of the blood, but how do they leak out of the capillaries? The stand is taken that they pass through the endothelial cells under a pressure of a few centimetres of water: but can molecules having molecular weights of many thousands enter, pass through, and emerge from the cytoplasm of endothelial cells where equally large molecules are abundant? If this be the way, there ought to be differential filtration, the smaller albumin molecule passing in greater abundance than the globulin, and yet, as the authors show, the ratio is approximately the same in lymph and plasma. The other way is between the endothelial cells, where there is discontinuity in structure between cytoplasm and intercellular matrix, surely a likely place for leakage. When we come to the passage of these proteins into the lymphatics from the tissue spaces a further difficulty arises: here there is no positive pressure to help the passage, and so some easier way than through the cytoplasm of the endothelial cell of the lymphatic vessel seems especially to be required.

Such interesting questions as these are excellently dealt with in the first 150 pages of the volume.

The rest of the volume deals with the function of lymphoid tissue and of lymphocytes. Lymphoid tissue composes about one per cent of the human body: it is a tissue especially well developed in mammals, and yet we do not know its function. The situation is unique: here is the physiologists' Cinderella.

It is a pleasure to record that this mystery remains the subject of hot debate and a playground for the investigator.

The fate of lymphocytes which enter the blood stream from the lymphatics is of interest. In the case of a dog of 10 kgm. about five thousand million enter the blood stream, via the thoracic duct, per day, sufficient to replace the circulating lymphocytes twice. Where do they go? Many possibilities are considered, but one, I think, has been somewhat overlooked. Not only do lymph glands produce lymphocytes, they also destroy them in large numbers by phagocytosis by macrophages. Perhaps production does no more than equal destruction; if so, the fate of great numbers would be accounted for, as well as a means of maintaining constancy in numbers.

In dealing with the effect of X-rays, the authors have missed an important finding. If a rat be given a very small dose of X-rays the lymphocytes fall to about 50 per cent: if then a second small dose be given no further fall occurs: if one waits until numbers have returned to normal, then a second dose produces again a 50 per cent reduction. There are therefore two kinds of lymphocytes in the rat: measurement of size shows that it is the small lymphocytes which are susceptible and the large resistant to X-rays. It seems possible that results might be more easily interpreted if we separated the large from the small, instead of considering them together. Advance has often been kept back by improper classification.

The final section of the book is entitled "Practical Considerations", and will be of special interest to pathologists and clinicians. Here such subjects as œdema, hypertension, shock, lymphatic obstructions and anæsthetics are discussed from the points of view of the lymphatic system.

J. C. MOTTRAM.

CHROMOSOME CHEMISTRY AND GENE ACTION

By DR. C. D. DARLINGTON, F.R.S.

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THROUGHOUT plants and animals the cell nucleus has a uniformity of structure corresponding to the uniformity of its work. This structure has to reconcile the mechanical requirements of cell division and reproduction with the physiological requirements of heredity and development. Its primary importance has led to its study by a great variety of physical and chemical techniques ; indeed, a greater variety than has been brought to bear on any other type of structure. Differential staining, X-ray diffraction and X-ray destruction, double refraction, micro-dissection, micro-incineration, ultra-violet spectroscopy and differential digestion as well as bulk analysis and the vast magnifications of genetic experiment have been used. They have all played their different parts in the solution of the problem.

The important agents are few and well defined. The nucleus consists of chromosomes which are enormously extensible protein fibres shown by digestion[1] to resemble the protamines and histones making up the bulk of sperm heads[2]. To these fibres, or rather to specific points on them, the chromomeres, are attached desoxyribose-, or thymo-, nucleic acid which is responsible for the specific aldehyde reaction given by the chromosomes in Feulgen's test[3]. Underlying the cycle of mitosis and cell-division is a cycle of attachment and detachment of this nucleic acid to and from the chromosomes. This goes with the cycle of coiling and uncoiling of their protein framework. The maximum attachment corresponds with the maximum spiralization of the chromosomes at metaphase of mitosis. At the other extreme, within the resting nucleus, they are uncoiled and relatively free from nucleic acid[4].

At the end of every mitosis the chromosomes give up their nucleic acid charge and at the same time secrete *nucleoli* which dissolve at the beginning of the next mitosis when the chromosomes are taking up nucleic acid again. These nucleoli contain no thymo-nucleic acid, but instead the ribose form which is characteristic of cytoplasm and of viruses.

The two nucleic acids differ only in the central sugar radical of the nucleotide. The desoxyribose radical apparently, however, gives its nucleotides a flatness to which they owe their capacity for polymerization. They form columns of plates which, as shown by polarized light, lie crosswise to the protein thread[5]. These plates agree in spacing at 3·34 A. with the extended polypeptide chain of the chromosome. It is this capacity which seems to make thymonucleic acid indispensable in the reproduction of the chromosome. For reproduction takes place by division of each fibre into two at the end of the resting stage, when the attachment of the nucleic acid charge is beginning[6].

The chromomeres, photographed by ultra-violet light, have been shown in a simple case to correspond with the units of X-ray breakage, which provide the physical definition of a gene[7]. Among chromomeres three special kinds of structure and function are found (Fig. 1). First there is the *centromere*, the movements of which control the movements of the chromosome on the spindle. The centromeres reproduce, or at least divide, not within the nucleus, but on the mitotic spindle. This delay in their reproductive cycle goes with a deficiency of nucleic acid at all stages of mitosis. If undivided lengthwise they will split crosswise on the spindle. They are, therefore, compound genes[8]. They may be regarded as spindle organizers playing a similar part to the centrosomes although living within the nucleus instead of outside it.

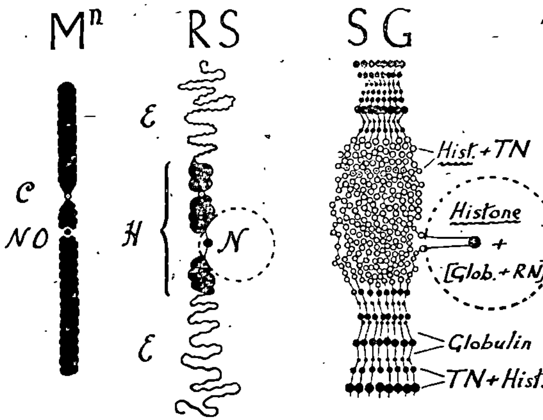

Fig. 1.

DIAGRAM OF A CHROMOSOME OF DROSOPHILA AT METAPHASE, NORMAL TEMPERATURE (*Mn*), RESTING STAGE (RS) AND AS A 'POLYTENE' STRUCTURE IN THE SALIVARY GLAND (SG), SHOWING THE DIFFERENT ORGANS REFERRED TO IN THE TEXT AND THEIR CHEMICAL CONTENT AS DETERMINED BY CASPERSSON. C, CENTROMERE; N O, NUCLEOLAR ORGANIZER; H, HETEROCHROMATIN; E, EUCHROMATIN.

Secondly, there is *heterochromatin*. Parts of certain chromosomes have long been known to show an abnormal retention or even extra charge of nucleic acid between metaphases. This property was first recognized in the sex chromosomes of animals, where it often goes with a modified timing of the reproductive cycle. Genetic evidence likewise reveals a differentiation. Certain parts of chromosomes, such as the *Y* in Drosophila, have long been held to be inert. They made little or no observable difference whether present in excess or absent altogether, and as might be expected, underwent no observable mutations. Recently it has been shown in plants and animals that the two properties of inertness and abnormality of nucleic acid cycle are combined in the same genes or chromomeres, whether making whole chromosomes or parts of them. These are then said to be heterochromatic as opposed to the active or euchromatic genes[9].

Thirdly, the nucleoli usually arise next to one or more particular chromomeres, the nucleolar organizers, which are again compound genes breakable by X-rays, and may be either at the ends or in the middle, either in a heterochromatic or a euchromatic part of the chromosome[10, 11] (Figs. 1 and 2).

All these different elements of nuclear structure, except the centromeres, are clearly visible in the giant nuclei of the salivary glands of Drosophila, and to these ultra-violet spectroscopy has been applied by Caspersson in combination with other methods. By these means he can distinguish quantitatively and qualitatively between the two nucleic acids or their nucleotides on one hand, with a very high maximum absorption at 2600 A., and the proteins with a vastly lower absorption and a maximum at 2750–2900 A. Of these he is able to distinguish between two types which he labels provisionally a histone type with a maximum above 2800 A. and a globulin type with a maximum which changes with the *p*H of the medium but is below 2800 A. in acid medium[4, 12].

The use of this technique has confirmed the picture so far outlined. But it has also gone much further. It has shown that the heterochromatin and nucleolus agree in having a high histone content. On the other hand, in the euchromatin the regions between the chromomeres contain globulin-type proteins. These higher proteins are lost in metaphase chromosomes or ripe sperm, in which only histones and thymonucleotides are recognizable. This leads Caspersson to argue that the active chromomeres or genes in the resting or gland nucleus are producing large globulin molecules while the inactive ones are producing small molecules of histone type which, although still individual, will be less specific in their interactions. The difference between activity and inertness would then be the difference between specificity and non-specificity; or better, perhaps we might say, between high specificity and low specificity. Further, Caspersson considers that the similarity of content between heterochromatin and nucleolus means that one secretes the material of the other, or we might suppose some precursor of it.

This view is confirmed by experiment. The addition of extra heterochromatin to the nucleus increases the size of the nucleolus in the pollen grain of Solanum[13]. A similar addition, in the shape of a *Y*-chromosome, to a Drosophila egg increases the concentration of ribose-nucleotides, or other pyrimidine-containing molecules, in the cytoplasm and likewise in the nucleolus[14].

Another connexion is revealed by the fact that the nucleoli are proportionately largest in cells which (with the exception of nerve-cells) are concerned with the most rapid protein production, for example, animal egg cells, meristematic and tumour cells. They are smallest in cells where no protein is being made, for example, in young animal embryos and in leucocytes. It is therefore significant that ribose nucleotide concentration increases as cells turn to protein formation. This is especially clear in yeast: nucleotides appear as soon as a source of nitrogen is added, having been entirely lacking even in the most actively fermenting yeast in the absence of such a source. Furthermore, the increase of ribose-nucleotides and of proteins goes with a specially high concentration of them next to the nuclear membrane where the proteins are shown by polarized light to be laid down in lamellar formation. They must be constructed on the very surface where nucleus and cytoplasm meet[15].

This is the argument. And Caspersson concludes that the nucleus is, as we should expect on even more general grounds, the centre of protein synthesis in the cell, that the nucleic acids are the essential agents of this synthesis, whether as polymerized thymo-nucleotides attached to the genes or unpolymerized ribose nucleic acid elsewhere. Further, Caspersson looks upon the changes in nucleic acid cycle of the heterochromatic genes as depending on differences in rate of protein production of the nucleus in different tissues, the genes being discharged of nucleic acid, their spiral threads uncoiled and their chromomeres separated in so far as the products of their own activities accumulate around them[4].

This account represents the first attempt to describe chromosome structure and activity in relation to cell processes as a whole. It is concerned with the types of molecules whose interactions govern these processes, but it does not tell us the sequence of their interactions. In order to discover this sequence, different methods are needed. Two kinds of experiment have so far proved successful. The first depends on the control of the general metabolism of the cell, or of the organism, by its inert chromosomes. The second depends on the control of the nucleic acid attachment of the inert chromosomes themselves by conditions which are developmental and genotypic as well as external.

The activity of the inert chromosomes or genes might plausibly be deduced from their widespread occurrence. But the precise study of their life-cycle in the individual organism and their distribution in the species makes it certain. Inert chromosomes frequently happen to have a defect of the centromere, which leads to their loss at mitosis. Even when this is not so, their irregular pairing leads to their loss at meiosis. Nevertheless, in species as remote as *Cimex lectularius*, the bed bug, and *Zea Mays*, indian corn, there seems to be a stable equilibrium of inert chromosomes in races or populations. The same is true of wild millet and cultivated rye (Sorghum and Secale). Such inert chromosomes must be preserved by positive selection. In some way they must be useful to the cells and the organisms containing them.

The case of Sorghum bridges the gap between plants and animals in another way. The inert chromosomes having weak centromeres are lost sooner or later in the development of all somatic cells. They are retained in the germ track. This distinction between soma and germ track recalls Ascaris, where parts of chromosomes, and Sciara, where whole chromosomes, are lost in all somatic cells. But in Sorghum we know that the chromosomes which undergo 'diminution' are in fact dispensable not only in parts of the plant but also in parts of the species. More than half the population have none. Diminution in the individual and equilibrium in the population are therefore two properties of inert chromosomes related by their common dependence upon being useful without being indispensable[16].

This condition of usefulness brings us back again to the notion that they are not indeed inert but rather non-specific in their activity; that their different products do not take part in a series of specific reactions co-ordinated in time and space with those of different active genes, but rather take part indiscriminately in all gene and cell reactions. This character might be due either to their production of smaller types of protein, as suggested by Caspersson, or merely to the control they have been shown to exercise over the production of nucleic acid.

Whatever the means, the end result, an effect of heterochromatin on cell division, is shown by the behaviour of pollen grains containing inert chromosomes in Sorghum. The first pollen grain mitosis, which produces the vegetative and generative nuclei, is normally followed after a week by the division of the generative nucleus to give two sperms. Instead, the vegetative nucleus in pollen grains with extra chromosomes at once divides again and goes on dividing until it has produced four or five generative nuclei, and in so doing has killed the cell. The thick wall confines this growth within the grain and makes it an encapsulated tumour.

These morbid mitoses suggest that the activity of the inert chromosomes in healthy tissues will serve to stimulate nuclear and hence cell division. Further, that healthy growth will depend on a correct euchromatin-heterochromatin balance, morbid growth on an incorrect balance, perhaps in cancer on a difference in balance between different cells of the same tissue.

The control of the nucleic acid attachment of the heterochromatin itself becomes from this point of view of more than trivial interest. Certain plants and animals with the largest mitotic chromosomes have well-defined blocks of heterochromatin amounting to a quarter or even half of the whole bulk. When the nucleus is brought into mitosis at a low temperature, below 6° C., equally in plants such as Trillium[17], Fritillaria or Adoxa[18], or in the newt Triton[19], the heterochromatin is starved of its nucleic acid. The segments in question appear scarcely stained by the Feulgen reaction. It seems as though the supply of nucleic acid has been reduced and the heterochromatin has been unable to compete equally with the euchromatin for the reduced supply (Fig. 2, below).

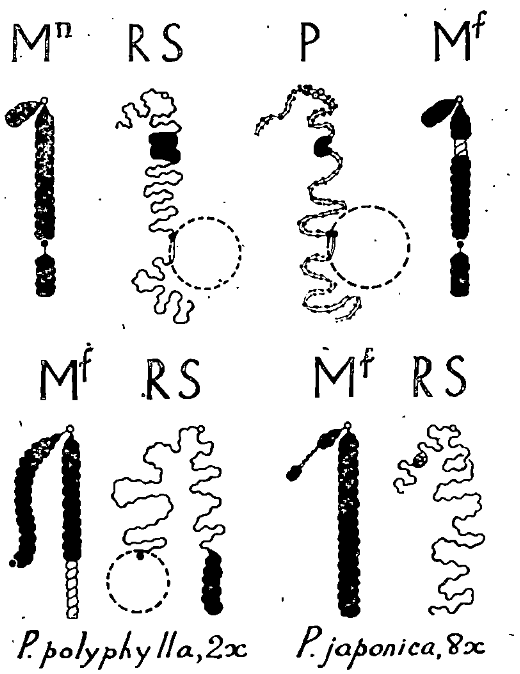

Fig. 2.

ABOVE: DIAGRAM SHOWING THE NUCLEOTIDE CYCLE OF A CHROMOSOME OF *Fritillaria pudica*. *P*, PAIRED AT PACHYTENE AND *Mf*, AT METAPHASE AFTER FREEZING. BELOW: INVERSION OF NUCLEOTIDE ATTACHMENT AS BETWEEN RESTING STAGE AND A CHILLED METAPHASE IN DIPLOID AND OCTOPLOID SPECIES OF PARIS. SPIRALIZATION OF HETEROCHROMATIN IS SUCCESSFUL IN *P. polyphylla*, UNSUCCESSFUL IN *P. japonica*.

This controlled starvation leads to derangement of two vital chromosome functions. First, the reproduction of the starved segments is hindered. Sister chromatids stick together, either at the ends or in the middle, and form bridges when they should separate at anaphase. This, when conditions other than temperature have happened to be abnormal, is a common source of chromosome breakage which in turn, by the way, must always lead to a change in heterochromatin balance[20]. Secondly, spiralization may be stopped and the heterochromatin appear as an entirely uncoiled thread at metaphase. This happens at meiosis in the male newt. Here the chromosomes have just emerged from a diffuse stage intercalated in the middle of the prophase and remarkable for having the heterochromatin uncharged, that is, for having no store of thymonucleotides. Similarly, it happens at mitosis in polyploid species of Paris and Trillium, which differ from diploids in having so small a stock of heterochromatin that again no thymonucleotides will be available within the nucleus (Fig. 2, below). Thus the nucleic acid attachment is necessary, not only as predicted for reproduction, but also for spiralization.

Conditions found in Nature advance the argument another step. In many animals of the heterozygous sex there is a large heterochromatic segment of the *X*-chromosome which is unpaired. In resting stages of the sperm mother cells and their antecedents this segment is strongly super-charged and there is no nucleolus. Apparently the transference of histones and exchange of nucleic acids surmised by Caspersson between heterochromatin and nucleolus has been blocked. During the prophase of meiosis this super-charging is strongest, and at the following metaphase a second remarkable property of the *X*-chromosome shows itself. Subject to variations in supply due both to genetic and to external conditions they are liable to fluctuate in their nucleic acid charge. They may be super-charged or sub-charged, or in the extreme case of the hamster Cricetus, they may be so little charged that they are unspiralized as in the experimental Triton[21]. Thus, like a lowering of the temperature, a suppression of the nucleolus can upset the regulation of the nucleic acid supply.

An adaptive effect of super-charging on reproduction is found in the Heteroptera. The normal pairing of the sex chromosomes is suppressed, and they divide at the first division instead of the second. Similarly, in many species of Drosophila there is a gene-complex 'sex-ratio' which exists in equilibrium in the population. Its effect is to increase the nucleic acid supply and therefore the charge on the heterochromatin at meiosis in the male. In consequence the division cycle of the *X* is advanced so far that it divides twice instead of once, and the *Y*-chromosome, immobilized by its heavy coat of nucleic acid, is lost in the cytoplasm. Hence the sperm all have *X* and the progeny are all female. This effect is reduced at higher temperatures so that up to six per cent of male offspring are produced. Evidently a causal sequence, temperature – nucleic acid charge – gene reproduction, is operative and can be used as part of the adaptive machinery of the species when it is combined with the usual high heterochromatic content of the sex chromosomes[22].

The imitation of natural abnormalities by experiment can take us further. Unfavourable conditions often produce a super-charging of the chromosomes. In maize a gene has this effect on the metaphase chromosomes, and an X-ray dose of 100 r. has the same effect. It is then found that the chromosomes are 'sticky'. What does this mean? When cold-treated chromosomes are X-rayed they show both stickiness and starvation. The charge on the heterochromatic segments remains less than that on the rest. They are thinner, but they are nevertheless coated with nucleic acid which stains deeply. It seems, then, that the stickiness is due to an excess of nucleic acid over the normal attachment and an excess with different physical properties[23].

The meaning of this effect becomes clearer when we realize that the X-rays act on the cell primarily by their effect on fibre formation: 50 r. will upset spindle development[23], but the germination of ripe pollen grains, a simple process not requiring fibre formation or even immediate nuclear control, is not disturbed by 80,000 r[24].

In this regard the distinction between fluid and fibrous elements, or at least surfaces, in the nucleus is important. The centromere, the nucleolus, the super-charged heterochromatin and the sticky chromosomes have a fluid surface. They run together. The normally charged chromosomes have a fibrous surface based on their fibrous framework. They stand apart. This difference between fluid and fibre would seem to depend on the polymerization of thymonucleic acid in contact with the chromosome. Here, again, there is a minor interlocking system of control, for while we saw that the nucleic acid charge controls the division of the centromere as well as of the whole thread of the sex chromosomes, the centromere itself often appears to act as the organizing centre for the charging of the chromosomes. At meiosis it then controls their pairing, which runs on a zip principle from the centromere to the two ends. In a word, the centromeres organize fibre formation both in the nucleus and on the mitotic spindle.

Thus we see a chain of reactions : the chromosome thread controls the polymerization of its thymonucleotide charge. This in turn controls the spiralization and, as would be expected, the reproduction of the thread with its genes. Hence the whole course of events can be controlled by temperature and other cell conditions as well as by the balance of heterochromatin and the organization of the nucleolus.

In this way the pattern of nuclear structure and organization is beginning to appear. But in answering some old questions we have, of course, raised far more new ones. Is the protein fibre of the chromosomes a single or a multiple chain ? Is a difference in multiplication or in charge responsible for differences in chromosome size ? Why have the prosthetic groups, which represent the genes and express themselves so clearly as chromomeres, active or inert, remained unidentified ? How does the nucleic acid attach itself to these groups and so control mating and reproduction (both limited to pairs) ? Is nucleic acid the agent of reproduction, or only of separation, of the main chain or of the prosthetic groups or of both ? If it controls spiralization, is it itself polymerized in a spiral with a limited number of stable positions ? How can the nucleic acid charge at prophase of meiosis be limited in quantity or arrangement so as to avoid reproduction and spiralization long enough to permit pairing ?

These and many other questions we can now attempt to deal with in a co-ordinated way. This we can do because at the same time that a new means of knowing the chemical structure and activity of the chromosomes and genes has been placed in our hands we also find ourselves provided with a variety of means of controlling this activity and modifying this structure ; with the instruments, in fact, for showing cell physiology and chromosome mechanics, no longer as opposite sides, but as interlocking parts of one system.

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[1] Mazia, D., and Jaeger, L., *Proc. Nat. Acad. Sci.*, **25**, 456 (1939).

[2] Kossel, A., "The Protamines and Histones" (London, Longmans 1928).

[3] Gulick, A., *Bot. Rev.*, **7**, 433 (1941).

[4] Caspersson, T., *Naturwiss.*, **29**, 33 (1941).

[5] Schmidt, W. L., *Naturwiss.*, **24**, 413 (1938).

[6] Astbury, W. T., *Proc. 7th Int. Genet. Cong.*, 49–50 (1939).

[7] Darlington, C. D., "The Evolution of Genetic Systems" (Cambridge, Univ. Press, 1939).

[8] Darlington, C. D., *J. Genet.*, **39**, 351 (1940).

[9] Heitz, E., *Z.I.A.V.*, **70**, 402 (1935).

[10] McClintock, B., *Z. Zellforsch.*, **21**, 294 (1934).

[11] Darlington, C. D., *Ann. Bot. N. S.*, **5**, 203 (1941).

[12] Caspersson, T., *Proc. 7th Int. Genet. Cong.*, 85–86 (1919).

[13] Lesley, M. M., *Genetics*, **23**, 485 (1938).

[14] Schultz, J., *et al.*, *Proc. Nat. Acad. Sci.*, **26**, 515 (1940).

[15] Caspersson, T., and Schultz, J., *Proc. Nat. Acad. Sci.*, **26**, 507 (1940).

[16] Darlington, C. D., and Thomas, P. T., *Proc. Roy. Soc.*, B, **130**, 127 (1941).

[17] Darlington, C. D., and La Cour, L. F., *J. Genet.*, **40**, 185 (1940).

[18] Darlington, C. D., and La Cour, L.F., "The Handling of Chromosomes" (London, Allen and Unwin, 1942).

[19] Callan, H. G., *Proc. Roy. Soc.* (in the press) (1942).

[20] Darlington, C. D., and Upcott, M. B., *J. Genet.*, **41**, 297 (1941).

[21] Koller, P. C., *J. Genet.*, **36**, 177 (1938).

[22] Darlington, C. D., and Dobzhansky, Th., *Proc. Nat. Acad. Sci.* (in the press) (1942).

[23] Darlington, C. D., and La Cour, L. F. (unpublished).

[24] Poddubnaja-Arnoldi, V., *Planta*, **25**, 502 (1936).

EDMOND HALLEY, 1656-1742

By DR. H. SPENCER JONES, F.R.S.
Astronomer Royal

ON January 14, 1742, died Edmond Halley, a remarkable man whose name is familiar to the public through the famous comet that is called after him. Born on October 29, 1656, in affluent circumstances, Halley took an early interest in astronomy. He went to St. Helena for two years, 1676–78, to observe the positions of bright southern stars, and while there observed the transit of Mercury of November 7, 1677, being the first person to observe both ingress and egress at the same transit. On his return, he published in 1679 the "Catalogus Stellarum Australium" ; in this he referred to the utility of observations of transits of the inferior planets for determining the solar parallax. Reverting to this subject in the *Philosophical Transactions* of 1694 and 1716, he proposed that the length of time taken by the planet to cross the sun's disk should be observed at a number of suitably selected stations ; from the differences in these times, the solar parallax can be inferred. The method has the advantage of not requiring elaborate instrumental equipment but suffers from the disadvantage that it requires the visibility of both entrance and exit at the same station. The method was widely used at the transits of Venus of 1761, 1769, 1874 and 1882.

Shortly after his return to England in 1678, Halley was elected a fellow of the then young Royal Society, of which in 1685 he became clerk and in 1713 one of the secretaries. In 1682 he made observations of the position of the bright comet that bears his name. It was probably this comet that turned Halley's attention to the consideration of the law of force under which an elliptic or parabolic orbit is described. He discovered in 1684 that for circular orbits with the sun in the centre the force for different orbits varies according to the inverse square of the distance. Being unable to solve the problem of the law of variation of the force for an elliptic orbit, he visited Newton in Cambridge in August 1684 to discuss the matter with him. He found to his surprise that Newton had already solved the problem and was able to supply the answer, but had mislaid his demonstration. Newton therefore worked out the proposition afresh and sent it in November to Halley, who made a further visit to Newton to encourage him to continue his researches. It was due to Halley's encouragement that the manuscript treatise, entitled "Philosophiæ Naturalis Principia Mathematica", which forms the first book of the "Principia", was presented to the Society in April 1686. The Society ordered that the book should be printed, but the state of the Society's finances at the time was such that it could not bear the expense. At the meeting of Council on June 2, 1686, it was accordingly resolved that the book be printed and "that E. Halley shall undertake the business of looking after it, and printing it at his own charge, which he engaged to do". Thus, as de Morgan remarked, Halley's "share in the production of the *Principia* entitles us to say that but for him, in all human probability, that work would not have been thought of, nor when thought of written, nor when written printed".

After Newton had demonstrated that the orbits of comets were sensibly parabolic and had devised a method for determining the elements of a comet's orbit, Halley collected all recorded observations of comets that had any claim to accuracy and computed the orbits of twenty-four comets. Among these were three that showed remarkable similarity: the comet of 1531, observed by Appian; that of 1607, observed by Kepler; and the comet of 1682, observed by Halley himself. Historical records of the appearances of comets in 1305, 1380 and 1456 confirmed his suspicions that these were all returns of the same comet. No method was then available for computing the perturbations due to the planets but, making an approximate estimate of the perturbing action of Jupiter, Halley concluded that the comet would be seen again about the end of 1758 or the beginning of 1759. "Wherefore", he remarked, "if it should return according to our prediction about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an Englishman." Intense interest was taken in this prediction as the time for the return of the comet approached; it was a test question put by science to Nature. The discovery of the comet on Christmas Day, 1758, and its perihelion passage on March 12, 1759, was one of the most outstanding triumphs that Newton's theory had achieved.

In 1625 Kepler had found that the observed places of Jupiter and Saturn could not be reconciled with their accepted mean motions. The inequality in the motions of these planets was explained by Halley as the effect of their mutual attractions. A more puzzling phenomenon was discovered by Halley in 1695. By examining the records of ancient eclipses, he was led to the conclusion that there was an acceleration of the mean motion of the moon. This was amply confirmed after Halley's death, and many of the greatest mathematicians and astronomers endeavoured to find the explanation. In 1787 Laplace announced that the acceleration was the result of a gradual decrease in the eccentricity of the earth's orbit, produced by the action of the planets on the earth. In 1853, however, J. C. Adams found that the calculations of Laplace were incomplete and that the correct theoretical value of the secular acceleration of the moon's motion was only about half the observed value. The cause of the residual acceleration was not found until 1920, when the work of G. I. Taylor and H. Jeffreys proved that it was the result of a gradual slowing down of the rotation of the earth, produced by tidal dissipation of energy in shallow seas.

Another important discovery made by Halley was that of the proper-motions of the stars. In the *Philosophical Transactions* of 1718 he announced that Sirius, Aldebaran, Betelgeuse and Arcturus had changed their positions in the sky since the time of Ptolemy; the old idea that the stars were absolutely immovable with respect to each other was thereby disproved.

But Halley was not merely a great astronomer. He made important contributions to many other branches of natural philosophy. In 1688 he produced the first meteorological chart, showing the trade-winds over the oceans, based partly on his own observations. He was interested in the theory of the earth's magnetic field. King William III, being desirous that the variations of the compass should be observed in various parts of the Atlantic Ocean, for the benefit of navigation, gave Halley a commission as a post captain in the Royal Navy in command of the pink *Paramour*. The voyage lasted for two years, 1698–1700, reaching as far south as lat. 52° 30′ S. Numerous observations of the declination were made, from which a sea-chart for the Atlantic Ocean, showing the isogonals or lines of equal declination, was constructed. This chart was published in 1701 and was a valuable aid to navigation. The novel method that Halley devised for exhibiting the data is still used for magnetic charts. In 1702 he published a more extended chart, covering the whole world, which he based on all available observations. In 1701 he also carried out for the Admiralty an exact survey of the tides in the English Channel.

Halley's versatility is further indicated by his construction of the first mortality tables, thus beginning the science of life statistics.

In 1703 Halley was appointed Savilian professor of geometry at Oxford. His labours in his new position were in the neglected field of the remoter Greek geometry. He translated and edited an Arabic version of the lost work of Apollonius "De Sectione Rationis". In collaboration with David Gregory, he undertook an edition of Apollonius. But, in consequence of the sudden death of Gregory in 1708, when less than a quarter of the work had been accomplished, it was left to Halley to carry it through to completion. This edition, the first and, until the latter part of the last century, the only printed Greek text of Apollonius, was a tribute to Halley's industry and scholarship.

On the death of Flamsteed, the first Astronomer Royal, in 1719, Halley was selected in 1720 as his successor at the Royal Observatory, Greenwich, being then in the sixty-fourth year of his age. Flamsteed's instruments, the cost of which had been defrayed out of his own pocket, had been removed by his widow, who claimed them as her own property and succeeded in maintaining her claim against the objections of the Admiralty. The Royal Observatory had thus practically to begin again. Halley obtained a grant for new instruments and equipped the Observatory with a transit instrument and a mural quadrant by Graham. The chief work he did as Astronomer Royal was to make observations of the moon through an entire saros period of eighteen years, with the view of improving tables that he had published in 1719; these were intended to enable longitudes at sea to be determined by the method of lunar distances. It does not appear, however, that the revision of the tables was ever attempted. Though Halley had a more versatile and original mind than Flamsteed, as Astronomer Royal he achieved less, for he did not so fully appreciate those habits of minute attention that are necessary for the attainment of a high degree of accuracy in routine programmes of astronomical observation. The work for which his name will remain famous was completed before his appointment to Greenwich.

Astronomer, geometer, mathematician, physicist, geographer, practical seaman and navigator, scholar and critic—Halley filled all these roles with distinction. As de Morgan said, "Wherever Halley laid his hand, to do work cut out by himself, he left the mark of the most vigorous intellect, the soundest judgment, the most indomitable courage against difficulties." The name of Edmond Halley will always hold an honoured place in the history of English science.

CONFERENCE ON SCIENCE AND THE WAR EFFORT

IT is natural to compare the Conference organized by the Association of Scientific Workers on January 10 and 11 with that convened last October by the Division for the Social and International Relations of Science of the British Association. The difference was striking. Whereas the October Conference was concerned with post-war planning, this conference discussed in a practical way the immediate scientific and technical problems of the War itself. Even more noticeable was the difference in the type of person who, in general, attended and spoke. Here were gathered together in the main rank-and-file men of science fresh from their work in laboratories, factories and research institutions all over the country. They came not only with grievances and criticism (of which there were plenty), but with proposals for better co-ordination of research and better utilization of our technical personnel. However, the Conference was not dominated by youth. An encouraging feature was the support it received from distinguished men of science, although the amount of this support would not appear to have been commensurate with the importance of the topics discussed. These topics ranged from the training of technical personnel and the university education of scientific workers to the organization of maximum productive effort. In addition, there were important contributions on the subjects of food and agriculture, and building, housing and A.R.P.

Sir Daniel Hall, vice-president of the Association, who opened the Conference, emphasized that men of science must have regard to the actual machinery by which Government is carried on, otherwise their proposals would receive scant consideration. He stated for the consideration of the Conference that the real problem was for scientific workers and the Government itself to find the machinery which would ensure a proper method of using the expert. Captain L. F. Plugge, chairman of the Parliamentary and Scientific Committee, welcomed the Conference on behalf of his committee, and expressed the hope that his Committee would be informed of the matters discussed, so that they could be followed up. New methods in building worked out as a result of the war-time shortage of materials were described by Dr. R. Fitzmaurice, of the Building Research Station. Prof. J. B. S. Haldane pointed out that had many of the recommendations of the A.R.P. Co-ordinating Committee been adopted, not only would there have been an immense saving of life but also a saving of materials and money.

Sir John Orr treated nutrition from the point of view of its effect upon the efficiency of the worker, soldier and civilian. He pointed out that considerable increases in food production are necessary to provide a decent standard of health. Dr. H. M. Sinclair, of the Department of Biochemistry, Oxford, emphasized that the primary cause of malnutrition is poverty, with the secondary factors of ignorance and the decreased availability of familiar foodstuffs. Sir Daniel Hall outlined a post-war policy for agriculture. He characterized the policy of high prices as a policy of scarcity, and called for national ownership of our limited land area. Sir John Russell, Prof. H. D. Kay, Prof. F. G. Gregory, and Dr. A. Walton contributed to an extensive discussion. Prof. J. A. Carroll called for a co-ordination between school and university, and for an inquiry by such a body as the Association of Scientific Workers into the scope and content of courses. Mr. J. A. Lauwerys discussed elementary technical education, and suggested that a closer contact between schools and the industrial world would be valuable. Both sessions on education were marked by the practical detail of the discussions.

The two sessions on January 11 were devoted to the place of the industrial and Governmental scientific worker in the war effort. Prof. W. Wardlaw, and Mr. F. M. H. Markham, of the Central Register, spoke and answered criticisms of the working of the Register. Mr. E. D. Swann, of the executive committee of the Association of Scientific Workers, outlined the Association's case for a select committee to investigate the whole question of the utilization of scientific personnel and for the production executive to appoint a technical personnel committee. Prof. H. Levy asked for a place for scientific men in the commands of the fighting forces, while Mr. F. Morgan, an operational research scientist attached to an R.A.F. Command, outlined the vital work which he and his colleagues are doing, and made suggestions for its improvement. Mr. Halse, of the Industrial Committee of the Association, gave numerous examples of inefficiency in the actual working of industry. Mrs. P. Clarke spoke of the low rates of pay of explosives chemists, which compare unfavourably with those received by unskilled personnel. Drs. Garland, Stanford and McClean made out an impressive case for better medical services in industry, and the consequent effect on production.

Scientific workers from a variety of undertakings took part in the discussions. The unanimous opinion seemed to be that production is being handicapped by lack of scientific training, mismanagement and inefficiency in high places, and through the spirit of peace-time competition between firms. Lack of contact between the Services and scientific workers was emphasized. Mr. J. A. Henley summed up this part of the conference while Prof. J. D. Bernal dealt with the proceedings as a whole. He stated that if the whole truth could be told, the situation would seem to be even worse than that described by the speakers from their first-hand experience. He said that attempts by men of science to better the situation would meet with opposition from industry and from the Government. In his view, the opposition to scientific workers in the last few months is equivalent to sabotage and perhaps something rather stronger. He underlined the need for speed in view of the urgency of the situation.

Thus ended one of the most significant gatherings of British scientific workers held during the War. It ended on a note of action, as representations by the Association are to be made to the Ministries of Labour and of Supply as a direct result of it. It is to be hoped that the facts which came to light will be most seriously considered by these Ministries.

OBITUARIES

Dr. H. Eltringham, F.R.S.

Harry Eltringham, who died on November 26, was the eldest son of J. T. Eltringham of South Shields, and was born in 1873. Educated at South Shields High School, and then at Durham School, he was destined for a business career with science as a background. His natural leanings to science owed much in his youth to his father's encouragement. He entered Trinity College, Cambridge, in 1891, and took an honours degree in natural science, after which he spent a year in the engineering 'shops' studying mechanical drawing and practical work. His father's shipbuilding business claimed him for some years after, but in 1908 he retired, and devoted himself to the study of insect mimicry, which had already attracted his attention.

Eltringham went to Oxford to study under Prof. E. B. Poulton, and in 1910 his fine book, "African Mimetic Butterflies", profusely illustrated with plates from his own coloured drawings, was published by the Clarendon Press. The intricacies of mimicry among Acraeine butterflies attracted him, and in 1912 he wrote a monograph on the African species of Acraea, thoroughly revising this difficult genus and describing new forms and species. Later, he treated similarly the neotropical genus Heliconius in a superbly illustrated paper (1916), discussing the specific and mimetic relationships.

Taxonomic studies necessitate anatomical research, and Eltringham was led to the histological studies for which he will be chiefly remembered. Field naturalists in Africa had described the habits in courtship of Amauris butterflies, which seemed to depend upon the charging of an abdominal brush with secretion from special areas on the wings, and dissemination of this presumed scent to the female by protrusion of the brush. Eltringham in 1913 described fully the histology of the parts in two species, following this account with a further paper in 1915. Similar structures in the allied Oriental genus Euploea were described in 1935 in a communication to the Royal Society, to which he had been elected in 1930.

These studies led Eltringham to consider other specialized structures, and numerous papers on glandular, tympanic, and brush-organs, and special sense-organs of unknown function in Lepidoptera and other insects came frequently from his pen at Oxford and, after 1935, from Stroud, where he equipped his own laboratory. One of the best known, entitled "Butterfly Vision", described with very finely executed drawings the minute anatomy of the compound eye. A microphotograph of Prof. Poulton, taken through the eye of a glow-worm, added interest to the discussion of theories of insect vision. One of the latest studies, in 1936, dealt with the eyes of tsetse flies. Eltringham's greatest histological successes were the description in 1920 of the apparatus, apparently for producing scent, concealed in a protrusible pouch in the back of the head of Hydroptila, a caddis-fly only a few millimetres long, and the account in 1933 of the anatomy of tarsal sense organs in Lepidoptera; also the account, published in 1928 by the Royal Society, of the silk-producing glands in the front tarsi of the small Empid fly Hilara, the amazing courtship of which had been watched by A. H. Hamm.

Eltringham's aptitude for drawing was enhanced by his engineering training: he despised no mechanical aid to producing accurate representations, and his illustrations demonstrate clearly what he describes. Similarly, his ingenuity enabled him to devise and make a vertical projection apparatus for drawing microscopical preparations, and a camera for very low-power microphotography. Other apparatus, such as a rocking stage for the microscopical examination of insects, keeping them always in focus, and an improved air pump for laboratory use, are on the market. His book on "Histological and Illustrative Methods for Entomologists" (Oxford, 1930) was the outcome of his own experience.

Eltringham also wrote in 1923 an engaging little book, "Butterfly Lore", dealing with the economy of a butterfly from egg to adult, and, in 1933, "The Senses of Insects". His last published work was "The Mind of the Bees" (1936), translated from the French of Julien Françon. The majority of his papers, numbering about seventy, were published by the Royal Entomological Society of London, of which he was president in 1931–32.

Eltringham was no mean athlete: he secured his Trial Eights cap at Cambridge and was well known as a skater in Switzerland, where he was twice among the judges at the English championships: he held the Gold Badge of the 'Bear' skating club. He was a friendly man but surprisingly self-contained: he had a keen appreciation of beauty in music and a colourful garden. He left Oxford to help his sister tend their mother at Stroud in her failing health, and after her death lived there. He was unmarried.

G. D. Hale Carpenter.

Mrs. Hertz

The death occurred on December 29 of Mrs. Hertz, widow of Dr. Heinrich Hertz, whose name will always be associated with the beginnings of radio communication.

Mrs. Hertz came to England in 1936, at the age of seventy as, although 'Aryan' herself, her husband's Jewish ancestry made it undesirable for her to continue to live in Germany. Admirers of her husband's work and the Marconi Company made it possible for her to live in England, and her two daughters also. The elder daughter had had a large medical practice among children at Bonn, where she lived with her mother; the younger did distinguished work in psychological zoology in Berlin, which she has continued at Cambridge.

Mrs. Hertz was a native of Karlsruhe, in Baden. A few years ago the late Pope made her a donation of £200 in acknowledgment of a gift of one of her husband's manuscripts to the Vatican Library. Another manuscript Mrs. Hertz generously gave to the library of Trinity College, in commemoration of Sir J. J. Thomson's eightieth birthday.

Joan Thomson.

We regret to announce the following deaths:

Mr. J. P. d'Albuquerque, formerly director of science and agriculture, Barbados, on December 20, aged seventy-five.

Major Edwin C. Eckel, chief geologist, since 1933, of the Tennessee Valley Authority, on November 22, aged sixty-seven.

Prof. D. D. Jackson, formerly professor of chemical engineering in Columbia University, aged seventy-one.

Prof. R. D. Rudolf, emeritus professor of therapeutics in the University of Toronto, on November 2

NEWS and VIEWS

Scientific Societies and Post-War Problems

AFTER winning the War of 1914, the Allies lost the peace because of the inability of statesmen and public opinion to understand the dependence of national security on world order and the dependence of world order upon truly workable international relations. After the defeat of Nazism, the mistakes of the last twenty-two years must be avoided by the victorious nations. Hitler has a 'new order' for Europe which is apparently an old-fashioned Roman peace. Aside from the very general Atlantic Charter signed by President Roosevelt and Mr. Churchill, no definite peace plans have been advanced by the Allies, although many groups both in and out of Government circles are working on aspects of the problem. The American Academy of Arts and Sciences is devoting its regular monthly meetings, November until May, to the subject of "Analysis of Post-War Problems and Procedures". The Academy, which has approximately eight hundred members elected from a wide variety of professional fields, includes men who are competent to give considered views on the natural and social sciences and in engineering and affairs; and the meetings are being held on the second Wednesday of the month at its Boston house under the chairmanship of Dr. Harlow Shapley, president of the Academy. On the Monday following, there is a forum directed by leaders chosen to discuss matters raised by the preceding Wednesday evening's speaker.

Prof. A. N. Whitehead, emeritus professor of philosophy at Harvard University, opened the series in November with a paper entitled, "Statesmanship and Specialized Learning"; Samuel Cross, J. Seelye Bixler and Hans Kelsen, also of Harvard, led the forum following this communication. The meeting on December 10 was concerned with problems of communication and transportation in a post-war world. Igor I. Sikorsky, engineering manager of United Aircraft Manufacturing Corporation, spoke "On the Air Transportation of the Future". Walter S. Lemmon, president of the World Wide-Broadcasting Foundation, spoke on "Radio as a New Force in the Post-War World". The forum on December 15 was led by Douglas H. Schneider, programme manager of Station WRUL, and Joseph S. Newell, professor of aeronautical structural engineering at the Massachusetts Institute of Technology. The January 14 meeting is being addressed by Zechariah Chafee, jun., Langdell professor of law at Harvard University, on the subject of "International Utopias". Among the topics for later meetings will be considerations of sources and availability of raw materials in a post-war world and discussions as to how the social sciences may best be utilized to implement the ideals of democracy.

Aircraft Defence against Barrage Balloon Cables

PHOTOGRAPHS of German Heinkel III aircraft, shot down recently, reveal the fact that these machines are fitted with a balloon cable fender not very different from designs tried by both sides during the latter part of the War of 1914–18. It consists of a metal rail, V-shaped in plan form, attached to the wing tips with the point of the V carried on a pylon forward of the nose of the machine. Thus, when meeting a cable it is fended off by being slipped round the wing tip. The weight and drag of the device is considerable, and has an appreciable effect upon the performance. British machines now use a row of small cable cutters along the leading edge of the wings. If the cable strikes between the cutters it slips along until it reaches the nearest one. This device is considered to be better, in that it releases the balloon, and clears the way for any following machines. The weight is less than that of the German fenders, although the comparative aerodynamic effects are not certain. The problem of ice formation on either type is likely to be serious, and in this case the British design, placing the cutters in the wing, which is probably already fitted with de-icing devices, is less likely to accumulate serious ice formations than the German exterior structure.

Czech Medical Work in Britain

SHORTLY after the Czechoslovak Government was formed in London, a Department of Public Health was set up under its Ministry of Social Welfare to meet the needs of Czechs in Britain and to prepare for the onerous duties that await them on the liberation of their country. There are about 250 qualified Czech medical men and women in Great Britain. Many are serving with Czechoslovak army units, others are with the merchant navy and some (in co-operation with the Red Cross) are concerned with the welfare of their countrymen resident in Britain. There are clinics and wards in certain hospitals at their disposal and a Czechoslovak Medical Association in Great Britain has been formed to hold regular scientific meetings. Through the Czechoslovak Research Institute, it has just issued the first number of a *Bulletin* in English, to which Lord Horder has contributed the foreword. Lord Horder points out that medicine knows no racial distinctions and recognizes no geographical boundaries. Both nations (Czech and British) are allies and friends opposing the medievalism into which Nazi Germany would thrust all man's endeavours. The paralysis of the advance of medicine which war induces is one of the most serious effects of the crime committed by Germany against civilization, yet Czech medical men are keeping alight the flame of learning and of healing so that, when victory comes, medicine will shine again in the new home they will provide for her.

The *Bulletin* contains several informative articles on current Czech medical work. Before it was overrun by the Nazis, the country had an efficient and well-organized medical service with one practitioner to every 1,500 inhabitants. There were 548 hospitals with 90,000 beds, while all classes of the community could take advantage of the country's unique spa and sanatoria facilities. After the War ends, Czechoslovakia will be in urgent need of medical men, and it is important that Czech medical students now in Britain should complete their studies in readiness for future duties in the homeland, where there is no rising generation of doctors since the Nazis have closed all the medical and scientific faculties of the Universities of Prague and Brno.

New Mexican Observatory

A NEW national observatory which will house a 24–30 in. Schmidt photographic telescope, claimed to be the most powerful in the tropics, is being built in Mexico. Other equipment will include a 12-in. reflector for visual observations and two or three cameras of the Ross type with apertures of 3–5 inches.

The observatory will be situated on a hill ten miles south of the city of Puebla, which is eighty miles east of Mexico City. This is a very favourable location in the southern hemisphere for observation. The latitude of the observatory is 19° N., which means that the sky can be seen to within 19° of the south celestial pole. The site is nearly eight thousand feet above sea-level. The work of the observatory will be closely linked with that of the Harvard College Observatory and of the Mexican Observatory at Tacubaya. It will consist largely of observations of southern variables and of star counts, colours, magnitudes and spectra for the southern hemisphere. The director of the observatory will be Mr. L. E. Erro, assisted by Dr. Carlos Graef, both of whom have already spent a year working at Harvard College Observatory.

Post-War Zoos

THE forty-first Bulletin of the North of England Zoological Society deals with the increasing difficulties facing societies which will have to maintain zoological collections during 1942, and makes a plea for public recognition of the zoological garden on the same standing as the art gallery and museum. The Society's zoo at Chester, like other collections at Dudley and Maidstone, saw a considerable increase in attendance in 1941 compared with the disastrous figures in 1940—Maidstone had about 40 per cent of normal pre-war years—and it is planned to invest money for post-war construction plans. "Not only in this country, but one might say all over the world, the problems of preserving the zoological collections will become more and more difficult as the war progresses from stage to stage" it is noted, adding, "It is very unfortunate that in the past both museums and zoos have suffered from a certain amount of apathy from both the government and the local authorities with the inevitable result that their development has been retarded. Many zoological societies have had to introduce various methods to raise money which most of them would like to have left entirely alone, but the necessity of raising funds left them no alternative. In the post-war period it is likely that art galleries and museums will receive more financial support from government and local authorities, but I am afraid that for some time to come zoological gardens will have to depend upon their pre-war sources of income." Among the post-war zoo ideas are a greater use of open spaces to display the animals to a better advantage, using ditches instead of iron bars and railings, to improve the labelling of exhibits instead of relying upon commercialized guide-books to impart the necessary information to the novice visitor, and more use of zoos by schools with the establishment of zoo lecture halls. The difficulties facing such schemes and how they might be overcome are dealt with.

The Birds of Leicestershire

THE Leicester Literary and Philosophical Society has formed an Ornithological Society for Leicestershire and Rutland, which is compiling a report on past and present field records, to be issued in 1942 as a preliminary to bringing up to date Montagu Browne's 1889 "Fauna of Leicestershire". A meeting in Leicester Museum last September decided to form an Ornithological Society, as a sub-section of the Leicester Literary and Philosophical Society, to meet monthly, Mr. F. Brady being elected chairman and Mr. A. E. Jolley secretary. A duplicated December bulletin, just issued, records the little owl, kestrel, partridge, red-legged partridge and a flight of grey geese within Leicester City bounds, and at the sewage farm a flock of tree sparrows, while a pectoral sandpiper is reported from Northampton Sewage Farm. At a large starling roost at March Covert, near Lockington, the ground was found to be littered with rubber bands believed to have been swallowed by the birds and later either vomited or passed in their excreta. They varied from fruit bottle to tobacco tin bands. Similar instances of this type have been recorded elsewhere with arctic terns, gulls and rooks, and it is probable that the birds mistake them for food, afterwards ejecting them as undigestible. At the flooded Wanlip osier beds, teal, pochard, shoveler and wigeon have been observed among the duck, as well as snipe, curlew and a peregrine. A sheldrake is recorded inland from the River Sence near Kilby Bridge. Although only opened in 1941 the Eye Valley Reservoir has already proved an important bird haunt.

Health of Scotland

ACCORDING to the report recently issued by the Department of Health for Scotland for the eighteen months January 1939 to June 1941, the health of that country in 1939 reached a level never attained before. The severe winter of 1940–41, however, was responsible for the deterioration in the first quarter of 1941 when the infantile mortality rose to 109. In 1939, 7,176 cases of tuberculosis with 3,526 deaths were reported, and in 1940, 7,670 and 4,003 respectively, while in the first half of 1941 the figures were 4,300 and 2,300. With the exception of tuberculosis, the War has so far not had much influence upon infectious diseases, unless the increased incidence of cerebrospinal fever be attributed to war conditions. There was an increase in diphtheria of about 50 per cent in 1940 over 1939, but in 1941 the incidence declined; about 440,000 children of school age and under, or approximately 40 per cent of the child population, have been immunized.

Rotation of the Milky Way

A SUMMARY of the most up-to-date knowledge of the galaxy is provided by an article by Frank K. Edmondson in the *Telescope* of September–October. A short historical outline of the subject is given, commencing with Glydén's discovery in 1871 of the galactic rotation effect in stellar proper motions, and dealing finally with recent research on the constancy of orbital velocity over a range of about 5,000–15,000 parsecs from the galactic centre. The explanation of this constancy in the rotational velocity is that the distribution of stars in the galaxy lies between high concentration towards the centre and uniform distribution. It has been estimated that the number of stars per unit volume near the centre must be a hundred times that in the neighbourhood of the sun. If this is correct, the sky should appear very brilliant in the direction of the galactic centre. As it does not do so, it is believed that huge clouds of dark interstellar matter partially conceal the centre from our view. For this reason the mysteries of that massive nucleus which lies behind the interstellar veil can be penetrated only through the assistance rendered by the study of star motions.

Electric Discharge Lamps

The War has forcibly directed attention to artificial lighting both indoors and out of doors. Black-out conditions in towns with their mentally depressing effects, their restrictions on social intercourse and their responsibility for more street accidents have emphasized man's dependence upon electric lighting. Indoors, particularly in modern factories which, like Hardwick Hall, are more glass than wall, the same black-out conditions have resulted in the continual use of artificial light even in the day-time. Specially welcome, therefore, is the interesting account of "Electric Discharge Lamps", written by V. J. Francis and H. G. Jenkins, recently published from the Research Laboratories of the General Electric Company in England. In about sixty pages an excellent technical account is given of "Osira" and "Osram" fluorescent tubes and their operating equipment. The many illustrations include spectrograms and oscillograms obtained from the tubes in operation. The story of the development of the tubes is an excellent illustration of the application of advanced academic physics in industry, and peace-time may well see the discharge lamp, historically the earlier, replacing the heated filament bulb.

Malayan Wild-life

Referring to the notes on Malayan wild-life in Nature of January 3, p. 17, Mr. F. F. Laidlaw writes: "the orang outan does not occur in the Peninsula, though it is of course found in Sumatra. The Malayan wild cattle is scarcely a bison, its native name should read sĕladăng, and the Malay name for the flying fox is kluăng. The common rhinoceros, now I believe preserved, was hunted for its horn, not for ivory, and the tusks of the Malayan elephant are usually too small to be of much value. It was hunted partly as a nuisance, and partly because it was an elephant! There is a likelihood of some confusion in the use of the term Malayan, meaning 'of the Malay Peninsula', opposed to Malaysian, which refers to the Peninsula *plus* the great islands, Sumatra, Java, and Borneo. For this latter concept 'Sondaic' might be better. 'Sundaland' is, I believe, used to denote all the lands of the Sunda shelf".

Synthetic Rubber in the United States

It is announced that the leading rubber, oil and chemical companies of the United States have agreed to pool their patents and technical processes to construct plants with a capacity of 400,000 tons of synthetic rubber a year. The undertaking is expected to cost about £100,000,000.

Announcements

The Bessemer Gold Medal of the Iron and Steel Institute for 1942 has been awarded to Mr. Eugene G. Grace, president of the Bethlehem Steel Company, in recognition of his valuable services to the iron and steel industries and in appreciation of all he has done to foster technical, scientific and industrial collaboration between the industries in Great Britain and the United States.

The Committee of the Athenæum has elected the following gentlemen under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services: The Right Hon. Sir John Anderson, Lord President of the Council; Admiral of the Fleet Sir Dudley Pound, First Sea Lord of the Admiralty; General Sir Archibald Wavell, Supreme Commander, South-West Pacific Area.

Father W. McEntegart, Heythrop College, Chipping Norton, Oxford, has written referring to Prof. W. G. de Burgh's review of Dr. Osborne Greenwood's "Christianity and the Mechanists" in Nature of November 29, p. 637, where the following passage occurs: "Even Aquinas held that reason could not disprove the eternity of the material world and that the belief in Creation could be authorized only by revelation". Father McEntegart points out, and Prof. de Burgh concurs, that the words "in time" should have been inserted after the word "Creation".

Dr. G. F. Herbert Smith, British Museum (Natural History), London, S.W.7, writing in connexion with the article "Nature Preservation and National Life" in Nature of Jan. 3, p. 1, states that the Conference of the Society for the Promotion of Nature Reserves, a memorandum of which is referred to, remains in being, and correspondence for it should be addressed to him.

Sir Arthur Hill, former director of the Royal Botanic Gardens, Kew, who died on November 3, left £93,379 (net personalty £92,653). He bequeathed £1,500 to the chapel fund of King's College, Cambridge, to provide carved statues in wood, a small statue of Henry VI, a silver tankard dated 1686, and his Dutch tiles to King's College; £200 to the supplementary expenses fund of King's College, and to a fellow of the College his doctor of science gown and hood; certain silver and other articles to the Archæological Museum of the University of Cambridge; £1,000 to the Bentham-Moxon Trustees of the Royal Botanic Gardens, his diaries of various journeys to the library of the Royal Botanic Gardens, and £500 to Kew Guild; his great Bible of Henry VIII to the Vaughan Library, Harrow School; £1,000 to the Royal Society; other bequests chiefly to religious bodies, and, after personal bequests, the residue as to one-eighth to King's College, Cambridge, and one-eighth to Marlborough College.

The Medical Research Council invites applications from medically qualified women for a studentship for training in methods of experimental psychology; preference will be given to candidates who have had some special training in physiology or neurology, or who have already had some experience in the use of research methods. The studentship will be tenable for six months during which the holder will receive training under the direction of Prof. F. C. Bartlett at Cambridge. Payment will be at the rate of £350 per annum, and the student will be expected to give her whole time to the work. The award will be made with the view of possible opportunities for research into problems arising during the War, either in the services or in industry, but no definite promise of employment after the expiry of the studentship can be given. Applications should be sent to the Secretary, Medical Research Council, c/o London School of Hygiene, Keppel Street, London, W.C.1, by February 9.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Colour Measurement

MR. J. W. PERRY's letter on colour measurement[1] may lead to misconceptions of the nature and status of the C.I.E. colorimetric system by colour workers who have not paid particular attention to the principles of colour measurement. In stating that the numerical colour specification $\chi_{\text{C.I.E.}}$ refers to (*a*) a normal observer and (*b*) normal observing conditions, including (*c*) a field of direct observation of 2°, Perry confuses the colorimetric standard with the procedure recommended for general direct colorimetry.

The 'standard observer' is a set of tables defining what is to be understood physically by colour, and has been adopted internationally for technical and commercial purposes. There is much evidence that this standard has proved satisfactory for a large range of such applications, and we know of none where it has been definitely found unsatisfactory. But whether the present tables are satisfactory or not, they are not restricted in their application to a given field size or field brightness or pupillary aperture or otherwise.

When measurements are made by the indirect spectrophotometric method, it is clear that these factors are irrelevant. Difference in colour merely means difference in $\chi_{\text{C.I.E.}}$, and can be specified to any accuracy attainable by spectrophotometry. Perry appears to think that, owing to the procedure adopted in the experiments on which the standard system was based, there exists a possibility of error in $\chi_{\text{C.I.E.}}$ values. But there is no possibility of error in what is by definition the standard, neither is there any tolerance. The definition is exact and unambiguous. The original measurements of Guild and Wright provided evidence that a standard based on their results would probably prove generally acceptable; once the tables based on these measurements were adopted as a standard, it became irrelevant whether they represented the visual properties of the groups of observers who contributed to the results with a high or a low degree of accuracy, and whether they were obtained with a large or a small field of view. There were in fact important reasons for choosing particular conditions, but it is unnecessary to discuss them here.

The recommendations for using particular conditions in general direct colorimetry were intended to guide a real observer in his efforts to obtain measurements likely to be in satisfactory agreement with the standard observer. When very small colour differences are to be measured, it is known that different conditions of observation should be adopted. It is possible that experience in these or other measurements may show that amendments should be made in the present standards to meet the increasing requirements of technical colorimetry. But any changes will be changes of detail and not of form. No new quantity χ_N, as proposed by Perry, involving a new physical concept, is involved in either differential or absolute colorimetry with large fields. The regional variation of retinal properties is formally irrelevant to appearances in an extended field. A physically uniform field will appear uniform in colour and brightness despite retinal variations, and colour matches with such fields will result in trichromatic equations of the same form as those obtained with a uniform field of small size. The results may differ numerically but not otherwise. In both cases the numerical differences from the C.I.E. values arise from departures of the colour vision of the real observer from those defined as the standard, that is, they are to be regarded as personal errors. It is well, however, to remember that it is only advantageous to use large fields for visual colorimetry when two specimens closely alike in spectral constitution as well as in colour are to be compared; the perception of a match or of small departures from a match is then very little affected by the observer's peculiarities of vision. In these circumstances all but extremely abnormal observers will obtain results agreeing with the standard to the limits of discrimination. Thus where a large field enables greater precision to be attained usefully, any consequent tendency for colour vision to depart from the standard becomes relatively unimportant.

We believe that Perry's difficulties about the standard observer are not real. Data of this type are formally necessary and sufficient for every colorimetric problem. If modification in the standard should ultimately be found desirable in the light of accumulated experience, it will be found a purely practical matter involving no change of principle. We can see no useful purpose that would be served by the philosophical inquiry desired but, to our minds, only obscurely indicated by Perry.

T. SMITH.
J. GUILD.
R. DONALDSON.

National Physical Laboratory,
Teddington, Middlesex.
Dec. 18.

[1] NATURE, 148, 691 (1941).

MR. J. W. PERRY's remarks[1] directing attention to the difference between the colorimetric concepts which he calls $\chi_{\text{C.I.E.}}$ and χ_N are opportune. As he points out, there is at present no real justification for applying the results of measurements made under the original standard C.I.E. conditions to problems involving other conditions of observation, and if nevertheless we do so, we must clearly realize that this procedure is at best a makeshift pending the publication of more detailed information. There is a need for fundamental research on the whole subject of the colorimetry of wide field systems.

The present position of colorimetry in the paper, printing and printing ink industry (and, I believe, several other industries) is this. If I have a sheet of paper which I have found by measurement to have colour *A*, it should be sufficient for me to order paper of colour *A* from the maker in the moral certainty that the paper, when it arrived, would match my sheet within commercial limits of tolerance; there should be no need for interchange of samples. Unfortunately, this is at present not so. Even if the paper mill and I both have visual colorimeters and they are used by experienced observers, it still does not follow that when the mill and I get identical colorimetric readings, that experimental making and sample will necessarily be a good commercial match. Of course, they may be so, and in any event they will not be *widely* different; but one cannot *guarantee* a match.

The trouble lies, of course, not in any fault in the design of our instruments, nor in a breakdown in the C.I.E. system, but in the fact that in practice the sheets are compared under conditions different from those laid down in the C.I.E. specification—conditions under which the eye is more sensitive. Further, I have taken as my example a favourable case ; but in industry the trouble is often aggravated by the use of 'colorimeters' of poor design and performance, constructed by works technicians with little knowledge of the principles of colorimetry. Now the 'practical man' in the trade tends to regard all instruments with suspicion, often, let us admit, with some justification ; and when colorimeters give the same readings when his own eyes tell him that the samples he is comparing differ appreciably in colour, no matter what the true cause of the discrepancy may be, he tends to lose faith in colorimetry altogether. This is regrettable, because if an improved method becomes available later—one which will be of real assistance to him—he will probably take no interest in it, saying that he has been 'caught' too often before. It therefore behoves one to be careful in introducing new instruments into industry.

Fortunately, as Perry points out, in many cases the papermaker would be quite happy if he had agreed colour standards to which to work, and a means of determining how far and in what directions the colours of actual makings of paper departed from these standards. What he really needs is a means of making sure that his own substandards do actually match the agreed standards, and a means of checking at convenient intervals the amount of discoloration of these substandards which may have occurred through ageing or chemical changes. This can be done conveniently and accurately by spectrophotometry, and it need not be done by the papermaker himself. The departures of different batches of papers from the agreed standards can then be studied over a limited region of the colorimetric field by means of a differential colorimeter of high sensitivity and precision, but only moderately high absolute accuracy. Photo-electric colorimeters which satisfy these conditions reasonably well are already available commercially. Until the fundamental work is done that Perry suggests, this procedure offers the best practical solution to the problem.

V. G. W. HARRISON.

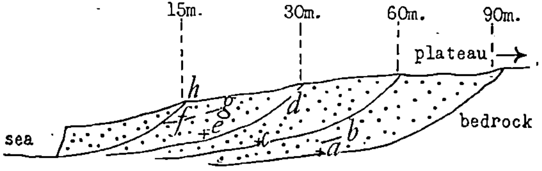
Printing and Allied Trades
Research Association,
101 Princes Gardens,
Acton, London, W.3.

[1] NATURE, 148, 691 (1941)

Pleistocene Raised Beaches on the West Coast of Morocco

ON the invitation of the Service of Antiquities I recently spent seventeen days in Morocco, studying the very important discoveries made by R. Neuville and A. Ruhlmann in the neighbourhood of Casablanca and Rabat.

The result of their work may be summarized as follows. The coastal deposits in this region testify to four separate marine transgressions during the Pleistocene, each followed by a period of retreat. The high sea-levels have left beaches at +90 m., +60 m., +30 m., and +15 m., corresponding to the Sicilian, Milazzian, Tyrrhenian and Monastirian beaches of Depéret. On each of these rests a complex of sub-aerial deposits—consolidated dunes, freshwater limestones, red clays—formed during the succeeding period of low sea-level. The whole series of beaches and sub-aerial beds forms a complete section of overlapping layers, as shown in the accompanying diagram.



DIAGRAMMATIC SECTION OF RAISED BEACHES AND SUB-AERIAL DEPOSITS IN THE NEIGHBOURHOOD OF CASABLANCA.

Up to the present the oldest known human industry in this region had been found in and on the 30 m.-beach, and was described as "Chellean". The work carried out by Neuville and Ruhlmann in the quarry of Abd-er-Rahman, near Casablanca, now gives a much more complete picture. Immediately overlying the 90 m.-beach (*A*) they found an extensive workshop of large heavy quartzite and sandstone flakes of Clactonian type roughly worked into bifaces, usually trihedral in section. The majority were unabraded, but a few were very slightly rolled, suggesting that the falling sea had occasionally returned to the level of the workshop. The accompanying fauna included hippopotamus and rhinoceros. The beach itself yielded shells of Acanthina (to-day found on the coast of Chile). The deposit containing the implements and bones was so hard that it had to be broken up with dynamite. In the overlying sub-aerial bed (*B*) was a horizon which yielded a few untypical flakes, and on the surface of the 60 m.-beach (*C*) similar flakes were found, again in small numbers.

CORRELATION TABLE

Mediterranean Beaches	Alpine Glaciations	Industries
90 m. (Sicilian) Beach	pre-Günz	Abbevillian Clactonian
Sub-aerial deposits	Günz	Untypical flakes
60 m. (Milazzian) Beach	Günz-Mindel	Untypical flakes
Sub-aerial deposits	Mindel	—
30 m. (Tyrrhenian) Beach	Mindel-Riss	Acheulean
Sub-aerial deposits	Riss	Acheulean
15 m. (Monastirian) Beach	Riss-Würm	Micoquian Mousterian
Sub-aerial deposits	Würm	Aterian

Overlying the 60 m.-beach are consolidated dunes, in which caves have been excavated by the sea which formed the 30 m.-beach. The floors of these hollows are covered with contemporary beach material, overlain by sub-aerial clays containing animal bones, and at the contact of the two types of deposit were found bifaces of Acheulean type.

The 30 m.-beach thus fragmentarily preserved is better developed in the neighbouring quarry of El Hank, where it yielded a large Murex, which replaces the Acanthina at this level, and the industry formerly described as "Chellean". I have studied the material from this level in the collection of M. Antoine, and find that it includes two distinct industries : (1) Abbevillian (Chellean), with bifaces made on pebbles and heavily rolled ; this is presumably derived from an older deposit broken up by the Tyrrhenian sea. (2) Acheulean, with typical and beautiful bifaces, some slightly rolled, but the majority unabraded. This must date from the end of the 30 m.-beach and immediately after, as in the caves at Abd-er-Rahman. Acheulean implements were also found in two dune deposits and a freshwater limestone overlying the 30 m.-beach (*F* and *G*).

The last marine deposit is the 15 m.-beach, and the history of an earlier stage is here repeated, for the Monastirian sea excavated caves in the consolidated dunes of the preceding period of emergence, and these contain sub-aerial deposits which have yielded an Aterian industry. Earlier than this, however, though slightly later than the 15 m.-beach, is a layer of red earth (*H*), which covers the sub-aerial deposits *F* and *G*, but does not belong to the same complex. This yielded Micoquian bifaces and a kind of rough Mousterian.

H. Breuil.

Change of Pelage in the Stoat *Mustela erminea* L.

The pelage change in captive stoats has been studied over a period of five years. The animals were caught at Ashton Wold, Peterborough, Northants, when only a few days old and hand-reared[1]. In this district the stoat normally remains brown throughout the year, although from time to time specimens are taken which show partial whitening in the winter.

Exposure to cold induced a colour change in three out of five stoats. In this particular experiment there was no artificial curtailment of the hours of daylight and no special feeding. The observations made may be briefly summarized as follows :

(1) The winter pelage may be white or brown.

(2) Captive stoats have two moults. This confirms Schwalbe's[2] observations made on wild specimens. The autumn moult occurs in late November, and the spring moult in February. The winter coat is thus carried for only three or four months. Examination of various skins shows that in northern districts the winter coat is carried for a much longer period.

(3) The date at which the autumn moult commences is generally regular, and unaffected by the temperature prior to the commencement of the moult, but the time taken for the moult to be completed is directly affected by the existing temperature. If it is low the entire moult and colour change can be effected in seventy hours. The extraordinary rapidity of the growth of the ingrowing winter coat has been demonstrated by shaving off portions of hair at this period. If the temperature is high, the moult may be spread over 10–20 days.

(4) Stoats from the same litter show great individual variation with regard to the change in colour. Exposed to similar degrees of cold, some display (*a*) no colour change, (*b*) a partial colour change, (*c*) complete colour change, (*d*) complete colour change repeated in subsequent winters, *even without renewed exposure to cold*.

(5) The degree of cold at the time of the autumn moult has a direct influence on the 'purity' or brightness of the white of the hair. When the change takes place without the direct influence of cold, but as a result of exposure to cold the previous winter, the white hair is, in comparison, of a yellowish tinge. It is nevertheless much whiter than the abdominal hairs which are normally also white during the summer.

(6) The autumn moult is always more rapid than the spring moult—the latter lasting for several weeks. It is almost irresistible to associate this with the relative suddenness of winter snow-fall and the more gradual disappearance of snow in the spring thaw.

(7) In the spring moult and in the gradual form of the autumn moult, certain well-defined areas of the body shed their hair before others. Thus, for example, the head and neck may show no sign whatever of moult of either the under-fur or guard hairs, when the rest of the body is already white. The moult commences on the underside of the belly.

(8) The moult is 'staggered' both with regard to the areas affected and the order in which the type of hair is shed. Thus the white under-fur grows in before certain of the brown guard hairs are shed. This adds to the dramatic effect of a sudden change, as the animal remains superficially brown when most of its hair is in reality white.

(9) Superimposed upon the phenomenon of the autumn moult is a limited blanching of some of the brown guard hairs before they are shed.

(10) Re-exposure to cold prior to and during the spring moult does not affect the colour of the summer coat, which grows in brown.

The frequent statements still appearing in the literature to the effect that the stoat has no autumn moult can probably be accounted for by the facts recorded in paragraph 7 and the rapidity and suddenness of the moult. The summer coat may be shed so precipitately that the hairs can be observed actually falling off as the animal moves about.

Miriam Rothschild.

Ashton Wold,
Peterborough.
Dec. 15.

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[1] Rothschild, M., *J. Marine Biol. Assoc.*, 24, 613 (1940).

[2] Schwalbe, G., *Morphol. Arbeiten*, 2 (3), 483 (1893).

Klino-kinesis in Paramecium

Mr. Yapp's communication on this subject[1] is of considerable interest because it suggests that temperature may be a more suitable stimulus than *p*H for making a quantitative investigation of klino-kinesis in Paramecium. A quantitative study is required to discover how completely the klino-kinesis scheme describes behaviour in gradients.

His statement[1], referring to the term *klino-kinesis*, that ". . . there does not seem to be any justification for its use, instead of the simpler term avoiding reaction, for the ordinary behaviour" calls for a reply. The special value of the term *avoiding reaction* is that it is plainly and vividly descriptive of what one sees Paramecium doing when it encounters a boundary where the intensity of stimulation changes suddenly. But Ullyott concluded[2] that the typical avoiding reaction (in Dendrocœlum) is a special case of the generalized type of behaviour in a smooth gradient, where there are no sudden changes of stimulation. If the reactions in a smooth gradient are called avoiding reactions, then this term loses its vividly appropriate character. The term *klino-kinesis* was invented[3] for the generalized reaction and intended to cover the avoiding reaction too, as it seems to do for Paramecium[4,5]; this term is further of value as part of a relatively homogeneous classification of elementary reactions[3,6]. It is worth while noticing that sensory adaptation is an essential feature of successful aggregation in the eccritic part of a smooth gradient, when a random turning mechanism is used[2,6], while it is apparently not so important at a boundary.

Mr. Yapp's conclusion would be justified, therefore, only if smooth gradients were merely "unusual experimental conditions" and sharp boundaries were the natural conditions in which "ordinary behaviour" occurred. I should have thought that in the habitat of Paramecium and on the microscopic scale involved, smooth gradients would be the rule and sharp boundaries the exception.

I agree that there need be no teleological assumption in using the term *avoiding reaction*[6]; but I suppose Mr. Yapp would agree that it would be a pity to use the term unless one could be sure that no teleological implication would be read into it.

D. L. GUNN.

Department of Zoology,
University of Birmingham.
Dec. 26.

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[1] Yapp, NATURE, 148, 754 (1941).

[2] Ullyott, *J. Exp. Biol.*, 13, 265 (1936).

[3] Gunn, Kennedy and Pielou, NATURE, 140, 1064 (1937).

[4] Yapp, "Introduction to Animal Physiology" (Oxford, 1939).

[5] Gunn and Walshe, NATURE, 148, 564 (1941).

[6] Fraenkel and Gunn, "The Orientation of Animals" (Oxford, 1940).

Rapid Determination of Water in Animals and Plants

DR. L. G. G. WARNE[1] is, of course, correct in maintaining that toluene with its boiling-point of 110·7° C. is preferable to xylol (b.p. about 135° C.) in the method recently described by me[2]. Unfortunately in the work which is going on at Plymouth one has to deal with large quantities of water and it is much easier to obtain xylol at the present time than it is to obtain toluene. I would like, however, to point out that the determination of water is only a comparatively small part of the work.

A method was devised in 1938[3] by which it is possible to weigh accurately such organisms as prawns, sponges, fishes or aquatic larvæ or embryos without removing them from the water, and this has opened up a vast field for research, for having weighed the fish or sponge one can then begin to carry out a quantitative analysis. Surely it will be recognized by all that this must have a great advantage over the older method of first, more or less, drying the organism or tissue and then carrying out the analysis.

Since 1938 the technique has been greatly improved and it is possible to weigh the organisms with much greater accuracy; but, of course, it is not possible to weigh a living sponge or shrimp with the same accuracy that one can weigh a crystal of quartz or calcite, and even if one could do so the figure would be meaningless, for the weight of a living organism must alter from minute to minute if not from second to second.

The displacement method of weighing has been fully described and discussed and I trust that a full account will shortly occur in the *Journal of the Marine Biological Association*.

The method of determining the water in organisms as recently described may be of great interest in another direction, for it is well known that drying an organism either *in vacuo* or in the oven even at a temperature at which most of the tissues would be charred or largely decomposed does not remove the ***bound water*** which is of such interest in biochemistry. It is quite conceivable, however, that even the bound water is removed by distilling the tissue under xylol or toluene.

Whether I was or was not the first to apply the Dean and Stark's tube for ascertaining the percentage of water in a sponge or prawn is a matter of no concern to me, and my sole reason for publishing a short account of the method was that I was urged to do so by Dr. Joseph Needham after he had seen a Soxhlet extraction apparatus used as a Dean and Stark's tube as described in my recent communication. It appears, therefore, that the method is not too well known in biochemistry.

A. G. LOWNDES.

The Laboratory,
Citadel Hill,
Plymouth.
Dec. 21.

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[1] Warne, L. G. G., NATURE, 148, 756 (1941).

[2] Lowndes, A. G., NATURE, 148, 594 (1941).

[3] Lowndes, A. G., NATURE, 141, 289 (1938).

Scientific Help for the Home Guard

MAY I through the columns of NATURE ask the technical help of readers for the Home Guard?

Although excellent equipment is now available to the Home Guard of an orthodox nature through the official channels, it still remains possible to supplement this by private ingenuity. I am inaugurating at this School a course in unorthodox weapons, gadgets and booby traps, and I would value information and suggestions from readers who have technical knowledge about how to make any of the following:

(*a*) Alarms to be attached to trip wires, etc.

(*b*) Detonators and electric circuits enabling mines, etc., to be exploded from some distance.

(*c*) Booby traps, electrically and otherwise controlled.

(*d*) Smoke bombs and methods of producing smoke screens.

(*e*) Home-made explosives.

(*f*) Home-made inflammable materials, such as the well-known phosphorus bombs.

(*g*) Home-made periscopes and other optical instruments.

(*h*) Simple signalling apparatus, buzzers, etc.

(*i*) Bird calls and other decoy noises.

In short, anything the physical or chemical properties of which can be usefully turned by the amateur to the successful harrying of the enemy. It is, of course, essential that these tools can be made by the amateur out of odd scraps of material likely to be found ready to hand. Certain of the things in the above list are for the moment prohibited, but this does not mean that it will not be worth while having at least the recipes by us in case the ban is lifted, either legally or by circumstance.

JOHN LANGDON-DAVIES.
(Capt. Commandant.)

Home Guard Fieldcraft School,
Bowmans, Burwash,
Sussex.
Dec. 30.

SCIENTIFIC AND INDUSTRIAL RESEARCH IN CANADA

THE twenty-fourth report of the National Research Council of Canada, 1940–41, includes the report of the president together with the reports of the directors of the various divisions (National Research Council of Canada. N.R.C. No. 1002: Twenty-fourth Annual Report of the National Research Council of Canada, 1940–41. Pp. 28. Ottawa: National Research Council of Canada, 1941). The former well indicates the extent to which Canada's scientific resources are being mobilized in support of the war effort. In addition to its former role the Council is functioning as a research station for the three fighting services of the Department of National Defence and also for the Departments of Munitions and Supply, and the president's report refers to the way in which the National Research Council has been able to turn its peace-time programme almost overnight into one of service in war. For example, the Section on Metrology of the Division of Physics and Electrical Engineering has been expanded to provide the organization required for gauge-testing, and to date there has been no delay whatever in dealing with this aspect of production. Similarly, the Radio Section was immediately turned to the development of secret radio communication and has made important contributions in the development of prototypes. The Section on Optics has dealt with the problem of optical glass and the manufacture of fire-control instruments, with the result that a well-equipped factory is already operating in Canada for the manufacture of optical glass and a wide range of fire-control instruments. The Section on Radiology immediately turned its attention to industrial radiology and has organized laboratories and trained personnel for inspecting castings at the various industrial plants. The Section on Electrical Engineering has been engaged on the design and production of secret gear and equipment in connexion with naval protective devices, while the Section on Acoustics has been devoting its entire attention to acoustic problems for the navy and the Section on General Physics has done much valuable work on the design of instruments, ballistics, etc.

In the Division of Chemistry the laboratories devoted to textiles, leather and rubber have been engaged in testing war materials, developing substitutes and the preparation of specifications for war materials. Research on the manufacture of ethylene glycol by direct oxidation has been continued with special reference to the stability of the catalysts. All research on methods of defence against chemical attack excepting training phases is directed by a special committee of which a member of the National Research Council is chairman and technical officers of the Department of National Defence and of the laboratories are members. This Committee has organized and directed more than twenty research projects with the various university laboratories and in the Chemistry Division at Ottawa, as well as supervised the manufacture of all the gas masks in Canada. In the Mechanical Engineering Division the wind tunnels have been engaged on many miscellaneous projects in aerodynamics, and extensive co-operative investigations on lubricating oils and fuels have been undertaken. The model-testing basin is engaged in studies in connexion with boats and floats, and considerable fundamental work has been done by the Division in the use of moulding plastic plywood construction. The Division of Biology and Agriculture has been concerned with many problems in the storage and transport of food which have become of prime importance owing to the difficulty of transport across the Atlantic. Medical research work has been carried out in close co-operation with technical officers of the Royal Canadian Army Medical Corps, and leading medical research men of Canada are working vigorously on important phases of war medicine. The National Research Council was also largely responsible for the organization of Research Enterprises Ltd., a Government-owned company formed for manufacturing certain special secret equipment from prototypes developed by the National Research Council. The report also refers to the intimate liaison established with the British Government and with research workers in Great Britain, and to the work of the Division of Physics and Electrical Engineering in selecting Canadian university men for special war service in the British Navy.

NEW SPECTROGRAPHIC OBSERVATIONS OF PECULIAR STARS

NEW spectrographic observations of peculiar stars were discussed by O. Struve and P. Swings, of the McDonald and Yerkes Observatories, at the Autumn Meeting of the U.S. National Academy of Sciences held during October 13–15. The McDonald Observatory of the University of Texas (which is operated jointly by the University of Chicago and the University of Texas) is equipped with a powerful ultra-violet spectrograph. Two large crystal quartz prisms and lenses of quartz or of ultra-violet glass transmit stellar radiations to the limit imposed by the ozone bands in the atmosphere of the earth. During the past two and a half years this instrument has been used to record the spectra of a number of peculiar stars which had heretofore been investigated only in the ordinary photographic region of the spectrum. The ultra-violet region of the spectrum contains many important features: the limit of the Balmer series falls in the near ultra-violet where the lines crowd together and where photo-electric ionizations produce a marked discontinuity in the distribution of the continuous spectrum.

Among the results obtained are several remarkable cases of changes in the spectra. Perhaps the most spectacular case is that of γ-Cassiopeiæ, which a few years ago was a normal emission line *B* star, and which in 1940 had an almost pure absorption spectrum with very sharp lines, while at the present time the absorption lines are broad and very diffuse. We know that the emission lines come from a tenuous shell around the star. For some, as yet, obscure reason the shell began to change a few years ago. The authors suspect that it started closing in towards the star, producing an intermediate stage spectrum of sharp lines. Finally, early in 1940, the shell must have largely fallen into the reversing layer of the star.

The opposite series of events has taken place in several other stars (*Z* Andromeda, *AG* Pegasi), where a new shell recently formed has expanded and has, in the case of *Z* Andromedæ, progressed from the sharp-line absorption spectrum to an almost pure emission spectrum.

These examples show that the processes of evolution in astronomy are not always imperceptibly slow. The outermost layers of stellar atmospheres are extremely unstable formations which often undergo marked changes in a few weeks or even days. Apparently these formations are supported by a delicate balance of three forces: gravity downward, towards the centre of the star, radiation pressure from the brilliant continuous spectrum of the photosphere directed outward, and radiation pressure within the Lyman alpha line of hydrogen from the tenuous shell. This latter force is directed inward in the deeper regions of the atmospheric shell, and outward in the outermost regions. A small disturbance of the balance of these forces causes the entire structure to collapse, if gravity predominates, or to expand, if the outward components of radiation pressure predominate.

USE OF SNOWFLAKE REPLICAS FOR STUDYING WINTER STORMS

By VINCENT J. SCHAEFER

Research Laboratory, General Electric Company, N.Y.

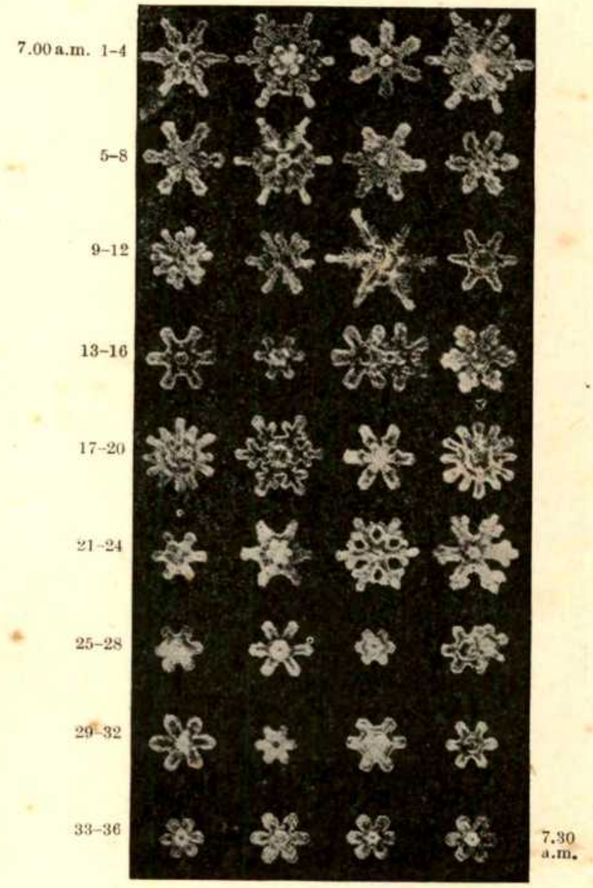
A METHOD was described last winter by me[1,2] for making permanent replicas of snowflakes, ice crystals and other forms of evanescent objects.

The technique, in brief, is to cover the frozen object with a cold dilute solution of an appropriate resin dissolved in a suitable solvent. After the solvent evaporates, a very thin continuous film reproduces in intimate detail all the surface configurations of the specimen. The substance of the original object is then removed by sublimation or by melting and evaporating, after which the resin shell, which optically appears identical to the original object, may be photographed and studied at leisure. A 1–2 per cent solution of polyvinyl formal[3] dissolved in ethylene dichloride (1–2-dichloroethane) reproduces excellent replicas of snowflakes and other forms of frozen moisture.

For collecting snowflakes a piece of black velvet stretched on a board is used to catch the specimens. A small drop of the resin solution is placed on a glass slide with a tapered rod. The rod, which still retains a small amount of the resin solution, is then immediately brought into light contact with the selected specimen and the flake readily adheres to it by surface tension. The specimen leaves the rod when it is brought into contact with the drop of liquid on the slide. All equipment is kept outdoors in a sheltered place throughout the winter.

Since the method of making permanent replicas is so simple, it would seem that those interested in winter weather phenomena might secure specimens from various types of storms for detailed study of these fascinating frozen forms in their possible relation to later meteorological occurrences. To illustrate these possibilities, the thirty-six photomicrographs reproduced herewith were obtained in a thirty-minute fall of large snow crystals at Schenectady, New York, U.S., during 7.00–7.30 a.m., March 12, 1941. During this short period, 150 specimens were collected and of these the 36 photomicrographs reproduced represent a typical cross-section of the replicas obtained. In securing these specimens the collecting board was cleaned every few minutes to make sure that representative crystals were secured throughout the fall. The photomicrographs were all made at the same magnification, so that the change in size as well as form can readily be seen in the photograph.

The climatic conditions when the specimens were collected showed a falling barometer at 29·70 in., a temperature of 26° F. with a north-west wind blowing. As happens frequently in this section of the United States, the crystal fall of large symmetrical crystals occurred at the close of a storm which deposited a total of about ten inches of snow. The snow of the storm contained a large amount of water (0·09 in. water per inch of snow) so that we would term it a 'wet' snow. At 7.30, when I stopped collecting, the symmetrical crystals were replaced by the more common non-crystalline forms of assymetrical flakes which continued for several hours, after which the wind changed and the skies cleared. It will be noted that the crystals collected at the start of the fall had a considerable amount of secondary deposits which gradually disappeared as they decreased in size and changed in form.



Other forms of frozen precipitation such as sleet, graupel and ice crystals, terrestrial forms such as columnar and tabular frost, as well as breath patterns and crystals of low melting point such as benzene and acetic acid may all be prepared in replica form by the method described.

---

[1] *Science*, **93**, 239 (1941).

[2] *Museum News*, **19**, No. 6, p. 11 (1941).

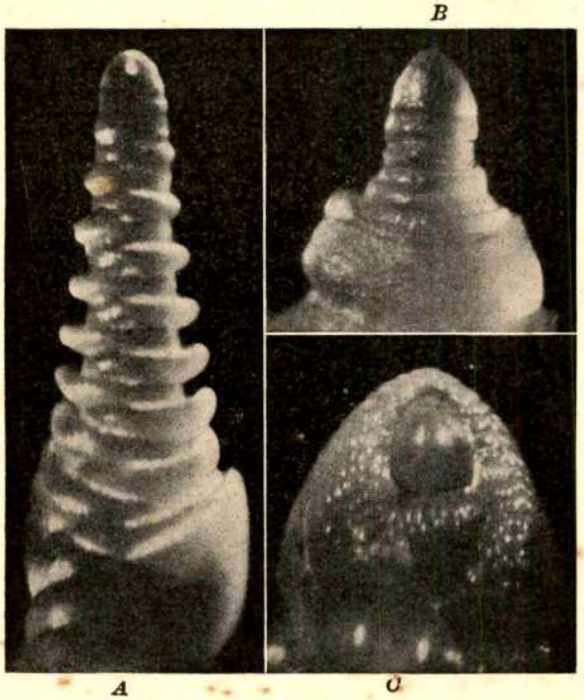
[3] Shawinigan Prod. Corp. Shawinigan Falls, Ontario, Canada.

SHOOT APEX IN GRASSES AND CEREALS

By DR. B. C. SHARMAN

Botany Department, University of Leeds

THE lack of readily available illustrations and literature on the morphology of the shoot apex in the Gramineæ, coupled with the fascination to be obtained from actually viewing the living growing point and the newly initiated primordia in various stages of their early development, prompt a note for the benefit of other workers. Using a mounted needle under a fixed lens (or for preference, a dissecting-microscope) a little care will enable the outer leaves of most grass shoots to be removed one by one until the very young primordia and the growing point are revealed. Of the grasses so far studied, *Glyceria fluitans* R.Br. is by far the easiest to dissect, since its leaves are conduplicate and possess little sclerenchyma, etc., so that the tissues cut exceptionally well and yield to the needle in a manner curiously reminiscent of snow.



× 100 approx.

Figs. *A*, *B* and *C* show vegetative apices of *Lolium multiflorum* Lam., *Glyceria fluitans* R.Br. and *Triticum vulgare* Host obtained in this way: the photographs, however, do not adequately convey their delicate translucent appearance. In Figs. *A* and *B* the apices are viewed perpendicularly to the plane of the leaves, so that the young primordia are seen arising alternately on the right and left of the axis as small crescentic protuberances some little way back from the actual tip. In Fig. *A* two young leaves at the base of the apex have been removed because although they did not obscure the tip, they did hide the lower primordia. For a similar reason in Fig. *B* a single basal leaf was removed. In Fig. *C* the apex is viewed in the plane of the leaves, one primordium being seen overtopping the apex while a younger one is partly exposed to view: a still younger one was found on further dissection.

Although at the outset the initiation is comparatively localized, it soon spreads around the apex so that a more ring-like structure is produced giving rise to the encircling insertion so typical of grass leaves. The primordium grows fastest in the region of its origin, and thus after a while appears as a small cowl growing over the tip and enclosing the younger leaves (see Fig. *C*). In vegetative shoots the buds are formed in the axils of the leaves after they have reached this stage and are leaving the immediate proximity of the apex.

The lengths of the apices vary considerably, species in the same genus often having apices of very different dimensions, but those of individuals of any particular species are usually of about the same length, especially if shoots of equivalent stages are examined. It is difficult to find a natural measure to express the length of the apex when comparing one with another. A useful ready method of comparison is obtained by counting the number of successive primordia from the youngest until one is reached which is sufficiently well developed to enclose the youngest leaves and overtop the stem tip. When the apices of a number of species are compared, it is seen that they can conveniently be divided into the following three groups, although a number of intermediate forms can always be found:

(1) A long type where some 12–20 or more young primordia are maintained as in *Lolium multiflorum* (Fig. A). Bugnon[1] in a longitudinal section shows eighteen primordia on the apex of *Melica altissima* L. which might well come here. In this group there seems to be much variation, more vigorous shoots having considerably longer apices than weaker or less mature ones. There seems to be a continuous lengthening of the apex up to the onset of inflorescence production, when buds appear in the axils of primordia which do not yet overtop the apex and have not left the apical region. Bud development rapidly becomes more precocious and the early growth of the primordia slower until the buds are the conspicuous feature and the subtending leaves no longer excite notice.

(2) In the intermediate type, which is not sharply delimited from type (1) and perhaps ought to include it, there are about 5–10 primordia on the apex as shown in Fig. *B* for *Glyceria fluitans*. This is by far the commonest type and includes most of the herbage grasses (for example, it is found in Agropyron, Anthoxanthum, Arrhenatherum, Dactylis, Holcus, *Lolium perenne*, Phalaris, Phleum[2] and *Poa annua*). Although more vigorous shoots usually have longer apices, in general the limits for each species are more clearly defined in this group, especially in types tending to have rather shorter apices. There is some increase in the number of primordia borne as the shoot matures, but at the onset of inflorescence production considerable elongation occurs (cf. Evans and Grover[2], and Weber[3]) accompanied by an accelerated bud production exactly as in type (1).

(3) In the third type the apex is very short (Fig. *C*) and commonly bears only one or two leaf primordia. Avena[4,5], Coix, Hordeum[5], Oryza, Secale[6], *Sorghum sudanense* Staph., Triticum and Zea as well as *Phyllostachys nigra* Munro[7] and Saccharum have apices of this type. It is prevalent in the cereals but is not limited to them. Typically, the apices remain short during the vegetative period and only elongate rapidly and suddenly at inflorescence production

when the axillary buds arise precociously, giving the appearance of double protuberances formed from the buds and the subtending primordia which remain as crescentic ridges (Purvis[8] and Bonnett[5]). This sudden elongation is very marked in Zea: in Triticum, on the other hand, there is a slight tendency to apex elongation during the initiation of the last three or four vegetative leaves.

It has been suggested[9] that apices of the short type are characteristic of annuals and that perennials tend to have the longer types, but the occurrence of short apices in Phyllostachys and Saccharum, and of long apices in *Poa annua* and *Lolium multiflorum* are not in accordance with this. Nor can the type of apex be correlated with a monocarpic or polycarpic habit since although many (? most) bamboos of the genus Phyllostachys, (see Kawamura[10]) die after flowering, this is not likely to be the case in Saccharum when it does happen to flower. Again, although *Lolium multiflorum* is a type with a long apex, after it has flowered a clone can often only be maintained with difficulty.

Nor does there appear to be any connexion between the degree of tillering and the type of apex. Coix, Phyllostachys, Saccharum and winter wheat all tiller well but have short apices. In a number of strains of maize with a more pronounced tillering characteristic, kindly sent by the Maize Genetics Coöperation of Cornell University, the apices were indistinguishable from normal non-tillering types.

The clue to the length of the apex probably lies in the behaviour of the provascular strands. If these are initiated early in the primordium and rapidly link up with the system lower in the stem, then early in its development the young leaf and its portion of the apex will be able to tap food supplies coming back from older leaves, and thus be able to grow rapidly so that it soon encloses the younger leaves and overtops the stem tip and at the same time is removed from the extreme growing region. In cases where the development or the linking up of the provascular strands is slow, there will be a 'piling up' of primordia and the consequent production of the long type of apex.

[1] Bugnon, P., *Mém. Soc. linn. de Normandie*, **26**, 21 (1924).
[2] Evans, M. W., and Grover, F. W., *J. Agric. Res.*, **61**, 481 (1940).
[3] Weber, H., *Planta*, **28**, 275 (1938); **29**, 427 (1939).
[4] Kliem, F., *Beit. Biol. Pflanzen*, **24**, 281 (1937).
[5] Bonnett, O. T., *J. Agric. Res.*, **51**, 451 (1935); **53**, 445 (1936); **54**, 927 (1937).
[6] Rösler, P., *Planta*, **5**, 28 (1928).
[7] Porterfield, W. M., *Peking Soc. Nat. Hist. Bul.*, **4** (3); 7 (1930).
[8] Purvis, O. N., *Ann. Bot.*, **48**, 919 (1934).
[9] Noguchi, Y., *Tokyo Imp. Univ. Col. Agr. J.*, **10**, 247 (1929).
[10] Kawamura, S., *Jap. J. Bot.*, **3**, 335 (1926–27).

INFLUENCE OF TEMPERATURE AND *p*H ON THE C/N RATIO OF SOILS

By PROF. N. R. DHAR and N. N. PANT,
Indian Institute of Soil Science, Allahabad

WITH ordinary soils the results obtained in different countries show that as a rule the higher the mean temperature of the soil the greater s the carbohydrate/nitrogen (C/N) ratio. Dhar and Mukherji[1] have reported that in India the C/N is highest in the soils from the Punjab with the average value of 14·4, in the United Provinces it is 11·3, in Bihar it is 9·2 and in Bengal the ratio is 9·1. In Wales it is 9·2. In the State of Washington after long cultivation the value is 10·2. In the Sudan it is 12·6 and in the Transvaal it is 14·4. It seems, therefore, that the C/N ratio of normal surface soils is in general an indication of the average temperature of a locality.

Experiments carried on by Dhar and Mukherji, in which normal garden soil samples collected from Allahabad, with a C/N ratio of 10·1, were kept in an air oven at 80° for more than two years, showed an increase in C/N with time from 10·1 to 13·5.

These results of Dhar and Mukerji showing that the C/N ratio increased in normal soils with increase of soil temperature are in agreement with those obtained by McLean[2] but are contrary to those calculated by Jenny[3].

In alkaline soils collected from Soraon and Saidabad near Allahabad and from other places like Bangalore (Mysore) it is observed that the C/N ratio of such alkaline soils is small and varies from 4·0 to 7·5.

(*A*) Soraon and Saidabad (Allahabad) Soils (0–9 in. depth)

*p*H	C/N
10·4	4·0
10·5	4·9
8·4	6·1
9·3	6·8

(*B*) Bangalore Soils (0–9 in. depth)

*p*H	C/N
9·8	6·7
8·0	6·7

When these alkaline soils are treated with reclaiming agents like molasses and press-mud or oil cakes the C/N ratio tends to increase as in normal soils. These results seem to be highly interesting, and show that alkalinity favours carbohydrate and cellulose oxidation more than protein metabolism. Alkalinity thus seems to oppose the influence of temperature on the C/N ratio of soils. Moreover, this small ratio of C/N in alkaline soils makes it clear that ammonium compounds do not occur in large quantities in such soils and the nitrogen store in soils may be the more complex protein compounds which do not undergo oxidation in the alkali soil as readily as carbohydrates and celluloses.

On the other hand, in soils where there is a tendency for the generation of acids, as in most cold countries, the C/N ratio should have a tendency to increase. In other words, in soils where the *p*H range is smaller than 7, it is expected that the protein oxidation would be favoured more than the oxidation of cellulose and carbohydrates. This conclusion is fairly well supported by the following observations on C/N ratio of acid soils in different countries.

The *p*H of soils collected from different countries are as follows:

Scotland	5–6·4
Finland	5–6·4
Japan	4·5–6·9
Denmark	6–6·9
Sweden	6–7·4
Java	6·5–7·9
Egypt	7–9
North India	7–10·8

It may be seen from the above data that, in general, the soils of cold countries have a tendency to acquire a lower *p*H value than those of warmer countries. The *p*H of some of the soils collected from different cold countries is given in the table below against the C/N ratio of such soils.

In Siberia some soils show a C/N ratio of 13·6.

It seems that two opposing factors are at work in controlling the C/N ratio of soils. In tropical countries,

	pH	C/N	Depth	Place	Investigators
Red Loams I	6·4	18·30	0–6 in.	Chaubatia (Kumaun Hills), India	Mukherji and Das
	6·8	14·20	0–6 in.		
Brown Forest Soils II	6·2	18·20	0–8 in.		
	6·3	12·70	0–1 ft.		
	6·5	18·90	0–5 in.		
	6·8	16·10	0–5 in.		
	6·2	19·04	0–1 ft.		
Podsol III	6·8	16·60	0–7 in.		
	6·0	16·90	0–1 ft.		
Wiesenboden IV	6·4	16·0	0–6 in.		
	6·7	15·84	0–9 in.		
Podsol V	3·70	29·24	6–9 in.	Shropshire, England	Davies and Owen[5]
	3·13	13·36	9–19 in.		
	3·73	23·48	19–23 in.		
Podsol VI	3·0	129·0		Northern New Guinea	Hardon[6]
	4·3	51·69			
Brown Earth VII	5·26	24·60	0–10 cm.	England	Muir[7]
	5·35	19·40	20–30 cm.		
Brown Plains Solod	6·17	23·96	0–3 in.	Saskatchewan, N. America	
	6·20	29·00	3½–7½ in.		
	7·07	21·90	7½–9 in.		

due to the influence of light and high temperature, the organic matter, which acts as a buffer, is readily oxidized from the soils, which have thus the tendency to be alkaline. With such soils, before the alkalinity is reached, the C/N ratio has a tendency to increase as observed by ourselves as well as McLean. But as alkalinity develops, the cellulose and the carbohydrates are oxidized more readily than the protein of the soil and the C/N ratio falls off. Hence the temperature effect is nullified by the alkalinity influence.

On the other hand, in soils in temperate and subtropical countries the organic matter added to the soil or present therein is not oxidized readily and hence such soils have a tendency to be on the acidic side, as illustrated above. But before it becomes acidic the C/N ratio may be in the neighbourhood of 10·0, as is frequently observed. But when the soil becomes acidic, the C/N ratio tends to increase. This is because in protein metabolism, ammonia is usually the first product of such oxidations and hence acidity may help the removal of one of the products of protein oxidation, namely, ammonia, and thus may help protein metabolism. Hence, in acid soils, protein metabolism may be faster than the oxidation of cellulose or carbohydrates, resulting in the increase of C/N ratio of such soils. This is why Jenny has obtained high C/N ratios in soils from cold countries.

The above conclusions are supported by the observations of Jensen[8] showing that 20–25 parts of carbon are oxidized in the nitrification of one part of nitrogen nitrified in acid soils, and by the facts that the acid soils in the paddy fields of Siam have 11·4 as the C/N ratio and the C/N ratio of virgin or prairie soils falls off from 13·6 to 10·5 after cultivation as observed in the United States and that the C/N ratio of Mauritius soils increases with increasing rainfall and soil acidity as recorded by Craig and Halais[9].

---

[1] Dhar and Mukherji, *J. Indian Chem. Soc.*, **11**, 727 (1934).

[2] McLean, *J. Agric. Sci.*, **20**, 340 (1930).

[3] Jenny, *Soil Sci.*, **27**, 168 (1929).

[4] Mukherji and Das, *Indian J. Agric. Sci.*, **10**, 990 (1940).

[5] Davies and Owen, *Emp. J. Exp. Agric.*, **2**, 193 (1934).

[6] Hardon, *Natuwik. Tijd.*, p. 25 (1934).

[7] Muir, *Forestry*, **8**, 25 (1934).

[8] Jensen, *J. Agric. Sci.*, **19**, 71 (1929).

[9] Craig and Halais, *Emp. J. Exp. Agric.*, **2**, 349 (1934).

FORTHCOMING EVENTS

Monday, January 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. B. A. Keen, F.R.S.: "Soil Physics, Theory and Practice" (Cantor Lectures, 1).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Dr. Kenneth Sandford: "Western Frontiers of Libya".

Tuesday, January 20

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. Ellis H. Minns: "Archæology in the U.S.S.R.".

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Rev. H. M. Grace: "Educational Problems of East and West Africa".

Wednesday, January 21

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. James Kewley: "Evolution in the Petroleum Industry".

Thursday, January 22

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Dome Lounge, Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—Prof. Patrick Abercrombie: "Re-Development of City Centres".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. C. E. Inglis, F.R.S.: "Aesthetics of Bridge Design".

Friday, January 23

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. Brian Reed: "The Future of the Railway Oil Engine".

Saturday, January 24

BRITISH RHEOLOGISTS' CLUB (in the Department of Physics, The University, Birmingham), at 1.15 p.m.—Discussion on "Classifications of Rheological Properties".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN PHARMACEUTICAL SUBJECTS at the Plymouth and Devonport Technical College—The Education Office, Cobourg Street, Plymouth (January 28).

HEADMASTER of the Junior Technical School of the Royal Technical College, Salford—The Director of Education, Education Offices, Salford 3 (January 31).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Psychological Society. Shelter and Evacuation Problems: being Papers read at a Meeting of the Society held on July 26th, 1941, and a Short Summary of the ensuing Discussion. Pp. 32. (London: British Psychological Society.) [1612

International Committee for Bird Preservation, British Section and Polish Section: Annual Report for 1939 and 1940. Pp. 32. (London: International Committee for Bird Preservation.) [1612

National Baby Welfare Council, including National Baby Week Council, 1941. Annual Report, 1939–40. Pp. 12. (London: National Baby Welfare Council.) [2412

Other Countries

Dominion Observatory Bulletin No. R.26: Report for the Year ended 31st December 1940. Pp. 4. (Wellington: Government Printer.) [2412

Government of Madras. Administration Report of the Government Museum and Connemarra Public Library for the Year 1940–41. Pp. 32. (Madras: Government Press.) 8 annas. [2412

Indian Forest Records (New Series). Botany, Vol. 2, No. 3: *Hopea shingkeng* (Dunn) Bor. By Dr. N. L. Bor. Pp. ii+227–230+1 plate. 6 annas; 7*d*. Botany, Vol. 2, No. 4: Some New Indian Flowering Plants: *Gleditsia assamica* Bor, *Garnotia puchiparensis* Bor, and *Strobilanthes andamanensis* Bor. By Dr. N. L. Bor. Pp. iii+231–240+3 plates. 14 annas; 1*s*. 3*d*. (Delhi: Manager of Publications.) [2412

Annual Report on Forest Administration in Malaya, including Brunei, for the Year 1940. Pp. ii+22. (Kuala Lumpur: Government Press.) 1 dollar; 2*s*. 4*d*. [2412

Department of Agriculture: Straits Settlements and Federated Malay States. Economic Series, No. 12: Malayan Agricultural Statistics, 1940. By D. H. Grist. Pp. xii+106 Tables. (Kuala Lumpur: Department of Agriculture.) 1 dollar. [2412

Report on Agriculture in Malaya for the Year 1940. By W. N. C. Belgrave. Pp. 14. (Kuala Lumpur: Government Press.) 1 dollar; 2*s*. 4*d*. [2412

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University Co

SCIENCE AND SOCIETY

MUCH indeed has happened since Prof. J. R. Marrack in 1937 contributed his stimulating essay on the "Social Implications of Biochemistry" to the volume of essays "Perspectives in Biochemistry" which was presented to Sir Frederick Gowland Hopkins by past and present members of his laboratory on his seventy-fifth birthday. It is now widely realized that not only, as Prof. Marrack pointed out, does the future trend of biochemical investigation into problems of nutrition depend largely on what form society takes, but also the whole trend of scientific work or even thought. The impact of society on science is as unmistakable as that of science on society.

That recognition has already found expression in important developments both in the field of science itself and in the world of politics. We have seen the formation of a new Division of the British Association for the study of the social and international relations of science. Nuffield College, Oxford, has been established as well as the National Institute of Economic and Social Research. Although the stress laid on research in the Report of the Royal Commission on the Distribution of the Industrial Population has yet to be implemented, the proposal in the minority report for the establishment of a commission of research covering all matters—land, agriculture, minerals, amenities, etc.—affected by national development finds widespread support.

In the field of politics account has been increasingly taken of the new knowledge of nutrition in handling questions of food supply and food production during the War, and there is evidence that Government is prepared to face the questions involved in the provision of diet standards based on the biochemical work of the last thirty years, and at least implement the possibilities thus opened up of raising the standards of health of a large proportion of the people of Great Britain through the provision of an economic and better diet by expanding social services, and a determined attack on malnutrition and its causes. That much, at least, is implied in the conception of a social minimum now gaining support, and its application is by no means limited to the people of Great Britain. Its bearing on the questions of Colonial welfare and development and on the feeding of the people of the enemy-occupied territories after the War, as well as on European economic and social reconstruction, are equally to the fore. The formation of the Bureau under Sir Frederick Leith-Ross announced at the second meeting of the Inter-Allied Council in September is evidence that practical effect is being given to such ideas, and the American co-operation then indicated will assuredly not be withdrawn or diminished now that the United States has entered the War.

The most striking feature of all such developments is, however, the immense amount of *ad hoc* inquiry, investigation and research which is still required over the whole range of the social sciences as a basis for policy and action. It is this that raises such studies to the priority level even in war-time, if having won the War we are not once again to lose the Peace. Even in the field of internal reconstruction the same condition holds. Lord Reith has already indicated the importance he attaches to research in a statement on the work of his Department made as long ago as February last year, and Mr. Greenwood, the Minister in charge of reconstruction, has stressed the importance of such surveys as those of the whole field of social insurance and allied services including unemployment assistance and workmen's compensation which Sir William Beveridge has undertaken. Further, plans are being made for the Agricultural Economics Research Institute to conduct a survey of problems of agricultural reconstruction when the necessary funds are assured. Mr. Greenwood has referred particularly to the North-East Regional Reconstruction Group of which Prof. J. H. Jones is honorary secretary. This is only one of several regional reconstruction organizations. Also, there are the investigations of Political and Economic Planning, and particular importance is attached to the work of the Demographic Survey of the 1940 Council. Mass observation, too, makes valuable social surveys, though we believe its scope and the intensity of its work are rather limited compared with similar social surveys and observations frequently made in the United States.

It is clear, therefore, that the importance of social research is recognized by the Government and that the co-operation of other institutions and bodies, whether local or regional, industrial or professional, is welcomed as leading to the development of new technique. Despite these numerous activities it also appears that not only is some real co-ordination and central guidance desirable but also much more effective financial support. In the absence of greatly extended Government assistance there is no evidence that many of these activities will be able to make more effective contributions than the Social Science Department or Economics Research Section of those Universities like Manchester and Liverpool which have already entered the field of social economics.

It is no disparagement of the work which has been carried out by such departments or by the National Institute of Economic and Social Research to suggest that with extended financial resources they might already have made much more important contributions to the solution of social problems of national and not merely local importance. This question of finance, with the further question of objective research, is in fact the vital one to consider in judging the proposal recently advanced by Prof. George Catlin in a letter in *The Times* of December 22, although regard should be had to the general background already outlined. The urgency of the need for more intensified research in the social sciences and a scientific examination of the impact of science upon society has been repeatedly stressed in NATURE over the last decade or so. A more biological approach is also an urgent need in the study of local, national and international policies, as is well argued by Mrs. Neville-Rolfe on p. 90—a thesis which she and others have been urging for some time past.

Prof. Catlin expresses his regret that the opportunity was lost ten years ago of establishing a social science research council as a genuine academic council representative of all branches of the social sciences in Great Britain. Such a scheme involving the survey of projects for research, the allocation of financial assistance and aid in personnel for the prosecution of such research and the direction of endowments into fields the probable fertility of which had been explored, would have done more than augment the resources of the struggling university departments or other research organizations. It would have provided an organ for an authoritative voice of the social sciences and immensely strengthened their position in respect of objective research.

On p. 88 Prof. Catlin urges strongly that the establishment of a representative social science body, of the highest academic standing and the fullest professional knowledge, that can freely express itself in a fashion that will command attention within this sphere is required to avoid the natural limitations of the Royal Society and the British Association with regard to social science. Such a body could have corrected many false conclusions in the past and could assist the Government and public authorities in many directions likely to be of paramount importance. Moreover, long-range work under such a council in fields, for example, like economic reconstruction and population studies, would be beyond suspicion of political bias.

This latter point is probably of the more importance since there is a sense in which the scientific work and thought which are required to provide the material which will enable social structures to be designed with full knowledge by Governments and administrators inevitably involves entering the political field. This, as Sir Richard Gregory has pointed out, is another matter from political partisanship, and provided the functions of the expert and the administrator are not confused there is no justification for the fear of science becoming entangled in contraversial politics presenting a bogy to the advance of the social sciences by the application of impartial scientific methods and principles to the problems involved in them. Indeed, Prof. A. V. Hill, in supporting Dr. Catlin's proposal, has suggested that the Royal Society might help, as it helped in establishing the British Academy in 1902, and while urging the application of the results of science to human betterment has uttered a warning against allowing our desire for betterment to upset our scientific conclusions or bias our scientific judgments.

Prof. Catlin's proposal has also been warmly welcomed in the correspondence columns of *The Times* by Mr. F. S. Stone, acting secretary of the National Institute of Economic and Social Research, who, indicating the willingness of the Institute to cooperate, points out that the Council of the Institute does not attempt or claim to cover many important branches of the social sciences such as anthropology and social psychology, although as Mr. Charles Madge has pointed out, the Council of the Institute is potentially the social research council for which Prof. Catlin asks. We take the view, however, that research in the social sciences to be effective must cover a much wider field—in fact, it must invoke the aid of almost every branch of science. We cannot, therefore, subscribe to Mr. A. Farquharson's view, expressed on p. 101, that "the narrower field [of sociology] may be appropriate as defining a useful field of operations for the present and that the wider view should not be dropped altogether out of sight". We envisage a much wider basis for the proposed activities, and this is illustrated by the other articles published in this issue. The foundation should be as broad and comprehensive as possible if the proposed organization is not to make the grave error of following a too narrow and specialized path. The President and Honorary Secretary of the Royal Anthropological Institute have also supported the proposal and indicated the willingness of that Institute to cooperate. Moreover, in their letter they stress the urgency of the need for such action.

The need for some kind of central research organization with adequate resources at the present time appears to be generally accepted, though the exact manner in which this need should be met gives rise to some difference of opinion. Prof. Abercrombie, stressing the need for scientific research into population problems, family units, industrial location, quality of farmland, transport, etc., with reference to planning for reconstruction, has suggested reconsideration of the proposal in the Minority Report of the Barlow Commission for a permanent commission of research as another alternative to the social research council worth examining.

The articles published in this issue of NATURE indicating the need for research in the various branches of sociology leave no room for doubt as to the imperative necessity of some such step. A much more generous endowment of such research through Government grants and the great foundations and trusts is to be hoped for to redress the disparity between our research effort in the biological and social sciences and in the physical sciences and to check the dangerous gaps arising through the unevenness of the whole research front.

The present proposals very clearly cannot be considered altogether without regard to the present structure and organization of scientific research as a whole in Great Britain. Moreover, there is some difference of opinion among our contributors as to the exact form of the organization required, and some clarification of thought as to the functions which it should serve must precede the establishment of any new body. Sir Frederic Kenyon, for example, visualizes some organization on the lines of the Royal Institute of International Affairs or of the Institute of Chemistry, for the collection of facts and the formation of opinion or formulation of principles in social science. Mrs. S. Neville-Rolfe suggests rather the formation of an Institute able to act in a consultative-directive capacity. On the desirability of a central research institution competent to attract investigators of distinction, to encourage co-ordination and concerted planning there is general agreement. Adequately financed and staffed and ably directed, such a central research organization, through its various departments briefly envisaged in the following articles, could make an immense contribution to the wise and effective use of our resources both in war and in peace.

There seems to us a grave risk involved in the suggestion that a Social Sciences Research Council be established along lines similar to those of the Agricultural and the Medical Research Councils. The ramifications of the social sciences go much farther and involve a larger number of special sciences than either of the other two, which are naturally confined to more or less well-defined though limited fields of action. Furthermore, these two already existing Councils have great assets in research personnel and accommodation for medical and agricultural research already existing in the universities, colleges and institutes throughout Great Britain. This cannot be said for the social sciences. Most of the special sciences become involved in sociology. Some receive attention from the point of view of their impact on society; but this only in certain universities and the various institutes already existing for the purpose which are specialized or are very narrow in their terms of reference. In the case of the social sciences, therefore, it seems that what is most desirable is the formation of a central institute with a permanent staff where research could be carried out or organized and deputed to university or other centres which already have the necessary staff and material. Research should be the key-note of the organization of such an institute; data would be gathered, sifted and correlated; funds administered; information supplied; and courses of lectures, refresher courses and vacation schools organized.

Platforms for the expression of points of view, for symposia on the social sciences and for discussions concerning the impact of science on society already exist and have done and are doing useful work. Almost every section of the British Association, for example, discusses in some way or another the social implications of its own particular scientific discipline, and the Division for the Social and International Relations of Science, under the chairmanship of Sir Richard Gregory, has already done work of inestimable value along these lines. Then there are the other more limited institutions and societies. But all these exist chiefly for the expression of points of view and for the determination of policy. Only within very narrow limits can they be expected actively to carry out research, and it is research in the social sciences which is so urgently needed. For this, some new form of central organization is, without doubt, badly needed, and now is the time for its foundation. Problems peculiar to war-time would receive prior claim, and thus would be laid a sure foundation for the development of the organization after the War, so that science could play a more practical part in the establishment and keeping of that kind of peace for which everyone is hoping.

CENTRALIZED RESEARCH IN THE SOCIAL SCIENCES

THE CASE FOR RESEARCH IN THE SOCIAL SCIENCES

By Prof. GEORGE E. G. CATLIN

Sometime Professor of Politics in Cornell University

IT is common ground that the task of social reconstruction after the War is going to take a prerogative position. Upon its success or failure is going to depend the future condition of Europe, and not only of Europe. In the alternative, we shall have not only a revolutionary epoch; but also a revolutionary epoch that is not even successful. The question here is whether this reconstruction is simply going to be carried through by practical men, dominated by the departmental notions of their own personal and limited experience, or whether the politicians are going to call in those who have, as a professional matter, made a systematic survey of the entire relevant data.

There is a second issue which, at the risk of paradox, I would venture to call even more important. It is that of the advancement of science. The social sciences have been embarrassed by the highly emotional and personal nature of much of the subject-matter with which they have had to deal—although it has been pointed out to me that medical science might have been overwhelmed by the same embarrassment (which has periodically threatened it) if it had lowered its standards of objectivity. To say that every economist is liable to be prejudiced, as the late J. A. Hobson said, is clearly true. To say that therefore there can be no economic science does not follow. The social sciences have suffered from the prejudice of those whose interests were liable to be undermined—so did the physical sciences in their day, but the enemy was then dubbed 'superstition', not 'practical sense'. They have suffered, as Hobbes said, from politicians who regarded them as 'dangerous', and even from eminent universities which have regarded them—as also the physical sciences were once regarded—as undignified upstarts. The great University of Cambridge declined to accept a grant for a chair of sociology, while the ancient University of Oxford had many, doubtless entirely necessary, chairs of divinity in various forms.

While the social sciences have been regarded as wicked attacks on the humanities by the humanists, they have, alas! been regarded as bastard little brothers by the physical and natural scientists. For some purist academics scarcely anything at all has been science save mathematics and mechanics. For others, no less dangerous, everything capable of being the subject of lengthy meditations has been *Wissenschaft* and science. As a kind of compromise, when the overwhelming practical importance of these sciences in a disturbed world could no longer be denied, the awakened practical men and journalists asked for 'scientific opinions', and the awakened citizen-scientists began to express their opinions in profusion. Astronomers, biologists and physicists talked about the nature of the State and the rectitude of credit and tariff, as did also the astrologers, and every writer of fiction or *belles lettres* who had what is called 'a name' and whose articles would sell easily in the commercial, popular press. On the whole, speaking from the point of view (which, of course, has to be considered) of the pay-box, the astrologers led.

For myself, I happen to be a humble political scientist who has spent twenty-two years on the job. The science is immature. Few even of my own colleagues agree with me in everything—but then, neither do the mathematicians agree. That there is a political science I contend along with Machiavelli and Hobbes, Spinoza and Bentham, Mill, Sidgwick, Marx and Lenin. Unlike the last, I hold that it can most helpfully at the moment be provisionally interpreted by the Hobbes-Adler hypothesis of the quest for power and that many of its hypotheses are capable of empirical and quantitative demonstration. These are deep matters, suitable for discussion elsewhere. But, since I put this argument forward (and I admit that it was received with acute scepticism) the work of Bertrand Russell on power, and the revolutionary 'mass observation' studies of Harrison and Madge seem to have done something to confirm it as the tenable hypothesis which alone I submitted it to be.

Political science, however, is perhaps the weakest and most uncertain (although, if Plato be right, the most august and promising) of the social sciences. Whatever be the quarrels of the schools, who will deny that a trained economist is more qualified to discuss economics than a layman ? Or a statistician statistics ? Or a psychologist psychology ?—although I have heard learned humanists at college high-tables demonstrating with finger and port glass that experimental psychology was *contradictio in adjecto* and, moreover, a waste of college funds.

The Social Science Research Council of America, for which I once had the honour of acting as a director of research on the subject of the socio-medical controls under the Eighteenth Amendment, has in its wisdom decided to include, within the field of the social sciences, economics, political science, sociology, anthropology, statistics (including vital statistics), psychology and history. The case of history must seem dubious, since it is generally agreed that there can be no science of history as such, but as a fact-classifying discipline the practical advantages of the inclusion of Clio in this company may perhaps outweigh the disadvantages. Plato's rule about the preliminary study of mathematics and Lord Kelvin's rule about the measurable nature of the material of exact knowledge are remembered. As has been well recognized in the School of Human Relations (which owes its establishment in large part to President Hutchins (now of Chicago)), there are various claimants for admission to the circle such as social hygiene on the margins of medicine, and criminology on the outskirts of law. However, the present system works.

This Social Science Research Council began in the United States in the middle of the 'twenties in quite a humble way, with a modest budget. It boasted no offices and not even a salaried secretary, but only a 'secretary to the chairman'. At this time Professors Charles Merriam and Wesley Mitchell played leading parts in getting the organization firmly established. There was little sign of that 'American over-organization' of which my old friend, Professor Graham Wallas, was afraid. Later, first Professor Lynd and then Professor Crane were appointed as secretaries general. The two famous reports on Economic Trends and

Social Trends were carried through by the Bureau of Economic Research and the Social Science Research Council respectively, the second under President Hoover's patronage and bearing his name as "The Hoover Report". The great prestige of the Council, with its princely offices, is something that has been built up on solid and vital work.

The failure of the Eighteenth Amendment, at great public cost and with inestimable damage to law observance, showed the danger of social legislation and even of 'noble experiments' carried through without adequate psychological understanding or sociological analysis. Nevertheless, it was clear, in about 1929, that there was going to be more social legislation deeply affecting the way of living of the community. The question was whether it was to depend upon power or upon knowledge, or upon mere muddle and afterthought. Financial aid was obtained from the Halley Stewart Trust in order to establish a preliminary committee to survey the social research work being carried out in Great Britain, as has been mentioned by me in the columns of *The Times*. Sir William Beveridge, Profs. Carr-Saunders, McGregory, Pigou and Wallas, Lord Stamp, Messrs. Farquharson (rapporteur), Stanley Unwin and others served. Some of us felt that the final report might profitably urge the establishment of a Social Science Research Council of Britain, and this was in some measure done. However, for reasons hat need not be discussed here, the broader scheme proved abortive. Largely owing to Lord Stamp's activity, the Institute of Economic and Social Research was established, to do valuable work. After talks with Lords Astor and Tweedsmuir and Mr. Tom Jones, the other scheme died. The humanists were not very sympathetic and there was some confusion between the fields of social research and social service, and also doubt whether only economics was mature enough to be regarded as a science.

At the same time suggestions were put forward for a scheme for strengthening legislation by party political research (a matter of interest to Lord Astor and to Mr. Wedgwood Benn, Mr. Roden Buxton, Sir Oswald Mosley and the Fabians) and for a Social Advisory Council to the Government, the latter being put forward in memorandum form in 1930 to Mr. Ramsay MacDonald. Later, the Economic Advisory Council (a very unfortunately constituted body) was established. The design, however, of those who were interested in thus 'rationalizing politics' was not to confound party politics or governmental policy with academic and long-distance research, but precisely, by he establishment of different although related organs, o distinguish these fields of propaganda, policy and research which are so habitually confounded.

For this reason, although I have noted with interest Prof. Patrick Abercrombie's suggestion in *The Times*, nd I believe there is a very strong case for reconstituting the ineffective Economic Advisory Council, would emphatically not be in favour of establishing ny academic council under the Cabinet, and still ess (Heaven forfend !) make any Civil Service department. Absolute independence, the staking of personal academic reputations for integrity, the highest tandards of objectivity, long-distance research—hese are the requisites. It by no means at all ollows that such research has no practical conseuences, and this of the most vital character.

I would take research into population changes as one instance. Great prejudices, economic and religious, are stirred. The sovereign pride and the national and racial rivalry of States are affected. It is all very difficult—and all very practical. The final war is the biological war. Many of the facts are matters of 'cold' statistics, although, of course, ultimate questions of values do not come within the purview of science. The medical man, for example, works on the hypothesis that the life of the patient should be preserved. There may be occasions when morally it should not. It is outside his province to decide the morals of infanticide but only to carry out the Hippocratic oath. That is his hypothesis.

There is probably a strong case for establishing an Institute of Vital Statistics, Demography and Social Biology. But no departmental institute can fulfil the work of the Council, nor can the institutes representative of other departments—anthropology, sociology, experimental psychology, industrial psychology or the various societies such as the Royal Historical Society be expected to serve under its banner. A general council is required.

On the analogy of what has already been done or recommended, I would suggest that the functions of a Social Science Research Council should be (*a*) to survey the field of the social sciences and to prevent overlapping in research ; (*b*) to provide a channel of financial aid from individual benefactors, public foundations and the Government ; (*c*) to pass upon and initiate schemes for research ; (*d*) to provide finance and aid in the provision of personnel and office facilities for such research ; (*e*) to publish, where desirable, the results ; (*f*) generally to promote the interests of, and to advance, the social sciences ; (*g*) to be an organ for voicing the collective opinion of social scientists on such occasions as it may be desirable to express them ; (*h*) to represent the social scientists of Great Britain at relevant international gatherings ; (*i*) to aid the Government and appropriate public bodies in social scientific research, when called upon to do so. I do not contemplate the Council members themselves being called upon, as such, to undertake research. This should be done by individual experts who are recognized authorities in their special subject, a background of advisers being supplied by sub-committees *ad hoc*. The function of the Council should be initiatory and generally supervisory.

The constitution of the Council involves more difficulties in Britain than in the United States, where every discipline has its own national association. I would, however, suggest that every holder of a chair or a readership in the selected subjects in the British universities should be *ex officio* a member, and probably also the directors of the relevant institutes and the presidents of the recognized national societies. It will be borne in mind that their main executive function, apart from the raising of funds, which can be left to the officers, would be the appointment of vigorous sub-committees to do the actual work. A special relationship would need to be established with the Royal Society, the British Academy and the British Association. But the less the American model, in constitution, is departed from the better—although, of course, a British institution can be expected to operate in a typically British rather than a typically American way.

The establishment of such a body, such as would gratify a Petty or others of the founders of the Royal Society, might well be one of the greatest steps for the advancement of science and one of the most original contributions to far-sighted and reasonable government in our century. It could do something to vindicate democracy as government by discussion, comment and reason, against government that claims to be efficient but rests on the principle of mere party power. Before there can be what is readily called 'scientific government' (be it 'scientific socialism', 'scientific business', or what have you) there must first be science, not apologetic but organized, independent, authoritative.

BIOLOGY AS A SOCIAL SCIENCE

By MRS. S. NEVILLE-ROLFE, O.B.E.

IF a social structure that provides for the emotional freedom and development of personality is to be the outcome of the present struggle, then an immediate effort must be made to harness individual emotional energies to this purpose. If the present world-wide destruction of man and his material assets by his fellow-men is not to inflict irreparable damage on civilization, man must make a supreme effort to safeguard and improve human quality. He must collate his scientific and spiritual values —to this end the gulf between the scientific and extra-scientific leaders must be spanned by as wide a bridge of common agreement as possible—direct his knowledge and energy to the fostering of individual emotional maturity and to the conscious control of his own evolutionary processes. Both intellect and emotions must be mobilized in the pursuit of a satisfying purpose in life, by applying to man the existing knowledge of social biology and by directing the desires and capacities of the present generation to further research (related to man) on personal and genetic development.

The knowledge and experience drawn from all parts of the world and from all groups working on biological problems—both theoretical and practical —should be immediately collated by an organization designed to promote its application and to foster further research.

To this end it is suggested that an institute having social biology within its purview should be called into existence, representative of scientific thought and world-wide experience, and able to act in a consultative-directive capacity.

Social biology is interpreted, for the purpose of this article, as including all those branches of science and administration directly concerned with man in relation to the genetic, traditional and environmental factors that shape his personality and influence his social relationships.

Many branches of general biology have contributions to make, including functional anthropology, genetics, psychology, physiology and biochemistry. The educationist, sociologist and statistician are also needed as channels of application as well as the administrator, the statesman, the medical man and the judiciary.

The time-lag between knowledge and practice in its application to the quality of man himself is unduly long. If the causes are recognized, it may hasten their removal.

Social Effects of Unrecognized Biological Factors

It has in recent years become obvious to some of our Empire administrators that man is being shaped to a large extent by his environment. The effect of soil erosion on tribal customs ; the effect on nutrition, and ultimately on fertility, of relating currency to cattle ; the effect of soil starvation and ove recruiting of labour on tribal and family life ; th break-up of tribal life brought about by intellectual imposed changes in spiritual values—all are problem of social biology and are now seen by some with clarity for what they are.

We recognize the effect of imposing Western factu knowledge on peoples whose emotional values ar still governed by tribal tradition. We can see th results of this unconscious but large-scale experimen in social biology among the detribalized African living in ports and industrial towns. Their emotion lives rooted in the traditions and governed by th values of the tribe, its family structure, its lan tenure, its totems and its magic are not integrate with the newly acquired factual knowledge, or wit the required behaviour pattern of a more comple culture. Unless these former deep-rooted an emotionally desired standards and customs are carefully re-interpreted and related to the higher value embodied in the European culture it is sought t impose, so that these are willingly accepted, there is deterioration in character, personal unhappines and a sense of frustration. Some apparently successfu experiments in social biology have already bee made—for example, the substitution of competitiv prowess in the hunt or in sport for the head-huntin qualification for full tribal membership and marriage and the modification of the original mutilatin initiation ceremonies to a form adapted to the ritu entry to a Christian community.

While we recognize the emotional childhood of th African and rightly explain his irresponsibility as du to the personal conflict between his own values an new knowledge, we have not recognized the sam conditions as obtaining in ourselves.

Psychology, anthropology and endocrinology hav of recent years widely extended our understandin of the emotional nature of man. Many well-known phenomena hitherto quoted as evidence of th 'unchangeability of human nature' are now seen a the result of infantile desires being unrecognized a such by the intellect and remaining as overshadowin influences or subconscious prejudices often impellin the adult to behaviour entirely at variance with th dictates of reason. A factor of supreme importance but not yet consciously applied, is that the firs appreciation of 'values' comes through the emotions An intellectual giant may be gravely frustrated i personal life by an uncontrolled temper, arising fro subconscious emotional causes, or by an emotiona immaturity which denies him the harmony of adjustment in marriage.

Human energy has been directed to training th intellect but has ignored the emotions. Knowledg will not affect behaviour or lead to action unti implemented by emotional driving force, which ca only be secured when both mind and emotion accep a common objective and purpose in life. Though this is known to the psychologist, it is not adequatel applied by the educationist, nor is it generally understood by the public.

Emotional Development of the Child

The Child Guidance, the 'Home and School' an the Mental Welfare Councils, and a number o individuals are working out techniques for th emotional development of the child, on the basis o existing knowledge, and indicating lines of researc and inquiry.

No systematic popular education has, however, yet brought to parents or to administrators that understanding of the emotional make-up of the young child that is vital if its needs are to be met. Under war conditions the quickest and most effective way must be sought to give the children of to-day the best opportunities of developing into emotionally balanced and mature adults capable of being responsible citizens of a real democracy.

To-day, even when an administrative reform is made, the general ignorance of psychology and social biology results in the cause of the reform not being understood by those who carry it into effect, thereby nullifying the intended advantages.

A number of the progressive local authorities and philanthropic organizations have already abolished the large institution for the care of children; but many have not appreciated that the reason for the change is to provide for the satisfaction of the child's emotional need for parent-substitutes, and therefore they omit to provide sufficient staff in the cottage home to enable any one person to express affection to the individual child, or to enable the child to have the emotional outlet essential to its development. They ignore the psychological reason for the change of policy. Nor is it appreciated that substitutes for *both* parents are required. A widow, untrained, charged with the entire care of twelve children, single-handed, has no time for 'mothering'; the frequent employment of widows, though it reduces the cost to pension funds, ignores the need for the father substitute. This is no small problem. It involves about 45,000 children in Great Britain—27,460 under local authorities and about 18,000 under voluntary bodies[1].

Unfortunately, most members of local public assistance committees and of philanthropic bodies have had no opportunity for acquiring even a bowing acquaintance with social biology. Yet, these same authorities to-day are often grappling with the vast problems of evacuation. Surely there is urgent need here for responsible advice and guidance if serious but avoidable war damage to children is to be prevented.

The Adolescent

Again, the personality develops at adolescence; the values and outlook then adopted will influence the youth and girl throughout life as citizen, marriage partner and parent; yet no systematic provision is made to explain the working of their own minds, bodies and emotions, to give them some idea of the interdependence of the different aspects of personality or to indicate how they may consciously integrate their own so as successfully to pursue a projected plan of life.

During the last ten years, as an emergency measure, about 100,000 of the 14–16 and 16–25 age groups have been given brief biological instructional courses on the place of sex in life, under the ægis of the more progressive local authorities and their youth committees by the British Social Hygiene Council, but what is that among the 6,571,800 young people of that age[2]?

What an opportunity is missed, too, in the administration of the National Health Insurance Acts, because our legislators and administrators did not appreciate their biological responsibilities!

Each year the young people leaving school for industry provide (supposedly) for their future health by registering under the Acts. In 1941 the age was lowered to fourteen and fifteen, the eligible entrants numbered 730,000, and these added their names to the medical men's panels. Unfortunately, under the name of 'health'—an ideal to be desired and striven for—only disease is paid for, or considered. The power to educate for health is in the preamble of the Act, but has never been implemented.

Social-Biological Problems

Knowledge of the effect of the endocrine equipment on character and behaviour has been available for years, but has not yet effectively influenced either our legal system or our moral judgments. In spite of the constructive work of the Institute for the Scientific Treatment of Delinquency, we still inflict prison sentences and label as recidivists many needing medical treatment and care.

No attempt has been made to relate new biological knowledge affecting man to our social values. This often results in social welfare and individual behaviour being at variance. Take, for example, society's attitude to health and disease. No teaching on the pyschology of the normal person—only the abnormal—is now included in the general medical training. Surely mental health is of paramount importance to the understanding of his patients' minds and emotions and is as essential to a medical practitioner as an understanding of their physiology and pathology.

Instead of a biologically minded community seeking the attainment of positive physical and mental health, and adapting the social structure to that attitude, there is a clash of values confronting the medical practitioner, which has seriously checked the application of science to man's development. As a social biologist the private practitioner should educate and work for the maintenance of health and the prevention of disease. As a citizen he must earn his living and maintain and educate his family. With our present knowledge of preventive medicine and our present form of medical organization, the two duties conflict.

Every professional barrier is raised to prevent medical practitioners taking an active part in popular health education; they in turn oppose every attempt at extending the field of preventive medicine through free clinics. The preventive early treatment of ailments and disease will, under the present system, reduce their means of livelihood. Even advice to the normal adult by competent lay people on preparation for, or adjustment within, marriage has been opposed by the medical profession, although the group of subjects concerned do not form part of ordinary medical training. Payments are made in relation to disease; the practitioner is not paid, as in ancient China, to keep his patients healthy. No community educated biologically would support a form of medical organization which created a vested interest in disease. That Western civilization has done so has undoubtedly been a factor in delaying the application of human and social biology.

It is cure of disease for which society pays and which therefore provides the large incomes.

Emotional and Intellectual Values in Conflict

One of the causes of the time-lag between knowledge and practice is the divergence between intellectually accepted truth and the traditional interpretation of spiritual or emotional values.

Although for two thousand years the statement that figs cannot be gathered from thistles has been repeated, had we applied the observation to man, and acted on it, we could have prevented the birth of many inherent defectives and increased the proportion of the genetically well endowed. The traditional opposition to selective parenthood persists. Emotional inhibitions have prevented the objective analysis and discussion of sterilization, limited even the discussion of entelegenesis to scientific journals, and buried in oblivion the interdepartmental report on abortion.

War conditions are directly affecting the number and quality of the coming generation, both born and unborn, yet no authoritative scientific guidance is available from those with real knowledge of the biological factors involved to those responsible for the mobilization and welfare of the man- and woman-power of the nation. It is urgent that existing knowledge should be reviewed and applied administratively to prevent ignorant good-will inflicting permanent genetic damage.

Young men and girls removed from home surroundings are marrying at short notice with no pre-marriage preparation or post-marriage help to adjustment. The result is a rising number of separation orders in 'war-marriages'. Some attempt is fortunately made by the Women's Services to keep marriage partners in touch, but no national policy in relation to the family is implemented.

Opposition to the use of vocational guidance arises from the widespread ignorance of biology. The effect on production and working efficiency of emotional anxieties is quite ignored, but is of serious import. The head of a training school for men between 19 and 21 reported that working efficiency had risen 10 per cent after courses of instruction relating to sex adjustment had been given.

The added personal responsibility deriving from the widespread knowledge and practice of contraceptives has altered personal values and necessitates constructive thinking. The increasing sense of parental responsibility accepts at a higher value the planning for a consciously desired child. The recognition of the value to individual development of both the play and the reproductive aspect of sex needs new social customs, new and personally accepted controls. A community seized of the truth of social biology will appreciate the impossibility of relating the spiritual and biological values of the 'unique relationship' in marriage, essential to full personal fulfilment, providing the required background for the child, and quite possibly an important instrument of human evolutionary advance, in a social structure that defers marriage until years after maturity, and for a large proportion of the population postpones parenthood beyond the optimum reproduction age. To-day, the emotional immaturity of the population and the absence of any attempt to relate new knowledge to emotionally accepted values in the field of personal and genetic progress limits emotional reactions in the mass to the primitive and childish. Hence the constant stimulus to irresponsible behaviour from commercially provided entertainment.

It is therefore of great moment that the proposed re-introduction of 'religious teaching' in the schools should take the form of an endeavour to inspire youth to rethink the traditional forms in which spiritual values are expressed; it is hoped authority will not seek to impose dogmas, but will clarify the truth they embody in a form that may go beyond, but would not conflict with, factual knowledge.

The dangerous ease with which false values may be presented to the intellectually ignorant in a for which will satisfy the mind and release the emotion drive is seen in Germany. The false values of aggressio and aggrandizement have followed the corre technique in the wrong direction, with the resulta chaos and disaster of a world war.

Science and Inspiration

There is a need to collate inspirational truth wit factual knowledge. Truth is expressed in man forms. The great religious leaders of the world hav proclaimed the facets of truth gained through intuitio and inspiration, in forms designed to appeal to th emotions. They have provided the positive philosophies of life that have been a major influence i dictating man's behaviour. Each inspired leader ha clothed his vision of truth in forms related to th knowledge and the social structure of the age i which he lived. Those religious systems that becom static and anchor 'truth' to the conditions of the ag in which they are formulated, die out; the ga between factual knowledge and religious teachin steadily increases—until the gulf between the emotional ideal and intellectual knowledge create divergent values, uncertainty of direction an ultimately, cleavage in personality.

Those religions that re-interpret the form an retain the spirit of intuitional inspiration are dynami and alive. Organized religion tends to oppose intellectual advance and takes refuge in an appeal t primitive emotion. This has probably been a important factor in prolonging the emotional childhood of man. On the other hand, workers in th field of science have tended to leave aside the real of values except as it affects them in common wit their fellow-citizens. Thus, when their views hav been expressed they are often accorded an authorit which they properly carry in their own subject, bu which they would be the last to claim in one the had not studied.

The Christian ethic asserts the unity of truth an the essential value of the individual personality. Th form has been constantly re-interpreted in the ligh of factual knowledge. The respect, for example, fo personality, which now takes a central position i its teaching, has only recently been interpreted a applying to women as well as men. A girl's marriag partner was arbitrarily chosen by her father, usuall on economic grounds, until quite recent times. Eve some bishops were polygamous up to the Middl Ages, and it is often forgotten that in an economicall ignorant world Church dignitaries opposed th abolition of slavery.

Values formulated from a small basis of factu knowledge, if unchallenged, retain their emotion appeal after discoveries and developments whic demonstrate their error have enriched the tradition intellectual inheritance; the old values become th prejudices of those who are too apathetic inte lectually and too fearful emotionally to challeng current interpretations. This is another factor in th time-lag.

The discoveries of the last three generations hav now created in living religions a dangerously wid gap between knowledge and practice, between inte lectual and emotional values, but that conscious an satisfying re-interpretation is possible can be demo strated by a personal experience.

Some years ago in India, it was my privilege t give a course of lectures on the development of th adolescent, to a large body of Hindu teachers. The span of years between the onset of the first physical signs of puberty and the attainment of physiological and psychological maturity was indicated. The Sarda Act was at that time before the country and the question of child marriage prominent in their minds. At the completion of the course, the chairman and members of the Teachers' Committee asked for a private conference. A number of pertinent physiological questions were put and answered factually and objectively. At the end, the chairman turned to his colleagues and said: "This is quite clear—we must have misinterpreted the Upanishads."

Social Biology in Administration

While man's further progress demands the projection of a unified and clarified ideal, there is no barrier other than that of the ignorance of the life sciences on the part of the responsible members of society to prevent the immediate application of much current biological knowledge that would promote human betterment.

Biology would appear to be of major importance to those responsible for leadership or who have jurisdiction over their fellows, at home or overseas—in Government and administration, the Church, the law, in the Defence Forces, industry, commerce and the social services. Yet, owing to present educational organization, it is among those who aspire to leadership that biological knowledge is conspicuously lacking. The majority of those seeking high office take the 'humanities' at the university. These are descriptive of the accomplishments of the mind and emotions of man—literature, history, language, but exclude the study of man himself as a living organism reacting to his environment, capable of the conscious integration of personality and responsible for the quality of posterity.

Dr. E. Lewis-Fanning carried out a small sampling inquiry in which "He extracted from the current Whitaker's Almanack, the names of the officers holding the rank of principal assistant secretary or a higher rank in various Government Departments. Of the 94 gentlemen in his sample, 42 were bred in the University of Oxford, 18 in Cambridge and 34 in some other or even in no university. We traced the academic careers of 40 of the 42 Oxford men and of the 18 Cambridge men. Of the Oxford men 31 took the School of Lit. Hum., 7 the School of Mod. History, 1 Mod. Hist. and Lit. Hum., 1 Jurisprudence and Lit. Hum. Of the Cambridge men 7 took the Classical Tripos, 5 the Mathematical Tripos, 1 each Natural Science, History or Law, 3 Mathematical and Natural Science, History or Law, 3 Mathematical and Natural Science Triposes. The sample is small, but a vocational bias of the humaner letters is indicated. Of the seven dignitaries in the War Office caught in Dr. Lewis-Fanning's sample, 5 had taken Firsts in Classical 'Greats'."[3]

A diplomat, administrator, politician or educator has at present no alternative but to become well acquainted with the biological sciences or to remain entirely ignorant of man's capacity to direct his own progress, so far as formal education is concerned, and is unequipped even to recognize the biological damage now often inflicted by social and administrative measures devised by the biologically ignorant.

We also have past errors to adjust. In recent reports on Colonial labour policies, stimulated by the International Labour Office, questions of social biology are constantly emerging. For example, the recent report of Major Orde Browne[4] describes the labour compounds of Northern Rhodesia and points out the human damage of these abnormal living conditions—a community preponderatingly male; such women as are present, are without their normal agricultural occupations and are passed on as temporary 'wives' from one man to another; the system encourages the spread of venereal disease and gives no stability for a family. But "the compound which admits of at least a proportion of married men is from every point of view preferable".

The malnutrition disclosed among the population of the fertile islands of the West Indies could not have persisted through three generations of general education had those in charge of administration, education and industry had an opportunity of sharing available biological knowledge. 'Education' had omitted any instruction or guidance in life or in the art of living. The cultivation, preparation and preservation of suitable food, use of local building materials, positive guidance in fitting the environment to the needs of man and the conscious development of man himself, all were ignored.

In 1939, with edible fish abounding in the surrounding seas, a population suffering from poverty and malnutrition paid for the import of 237,541 cwt. of canned fish[5].

Factual knowledge, without emotional development, cannot civilize the individual. While it is one of the assets of British secondary school education that 'character training' is an admitted objective, the type of character is that adapted to the British social structure. Colonizing governments have tended to transfer unadapted the educational system of the Mother Country to conditions overseas. Formal education is seen in its true colours in such new settings. It appears largely as a memory gymnastic, without influence on the man or woman as complete personalities. The facts memorized are unrelated to the emotional life or to traditional spiritual values; therefore, like discarded religious dogma, they have but little effect on behaviour. Such education tends to split rather than integrate the personality, to promote rather than resolve emotional conflicts.

For example, the deep-rooted and subconscious rhythm hunger of the African has been repressed, not drawn out and utilized, as a powerful aid to emotional development. This has had one peculiar result, with which I came in contact in Jamaica. Primitive African tribal dances can be seen and heard at dead of night in distant valleys or river beds—the rhythm of the music and the chant of the voices being African in cadence and tone. While the words, when analysed, are those of a Moody and Sankey hymn, the form and spirit of the dance are those of the African tribe. It is reported that primitive tortures have been inflicted under conditions of rhythm-ecstasy to enforce a local idea of Christian morality.

Again, the churches relate the 'value' of 'modesty' to the covering of the body with clothing, irrespective of skin colour, culture or climate. The West Indian is a practising Christian, therefore is fully clothed. The climate is tropical and heavy rain showers frequent. Many have no change for night clothing. In the old huts with mud floors the damp was absorbed; by the modern concrete floors it is not. Responsible local medical opinion recognizes this as one factor in the high tuberculosis rate. Another is the persistence of the deep-seated fear of the 'duppy' (the ghost spirit in bird form) which has been unresolved, because ignored, by education. Tradition decrees that all windows are hermetically sealed at night; however crowded the room.

It is only to be expected that in the West Indies to-day Major Orde Browne can report, "there is a lack of objective or purpose among young people nearing the end of their school days"[5].

The anthropologist and the psychologist need to co-operate with the educationist in designing the technique of cross-culture education.

Is it not urgent that those searching for truth in the laboratories and by observation and those experimenting in its application to man in the different parts of the world (now available) should be brought into close collaboration ? The discoveries of scientific workers and the experiences of administrators in India and the Empire would be of real value to the directors of education and to the youth committees of Great Britain. The collation of information and analysis of the problems would be facilitated by such a forum and study-circle as could be provided by an institute which had research in social biology as one of its active terms of reference.

Social Biology in Education

A serious factor in checking progress is the almost entire omission of human or social biology in the curricula of British universities, teachers' training colleges and schools. It is claimed that the younger generation are better placed to rethink values as they are less influenced by current prejudice, and recently acquired intellectual knowledge is more vivid. It is therefore vital that youth should be equipped with all available factual knowledge that bears on man himself and his potential development if their philosophy of life is to embody the nearest present perceivable approximation to truth.

Without a minimum of general understanding of biological principles, such discoveries as are made find no receptive public ; there is no general critical and knowledgeable body of opinion to relate new facts to existing problems, and no appreciation of the value to man of the progress made possible by the efforts of the scientific worker; hence the absence of financial and social recognition for the biologist.

Funds have in recent years been available for research in agricultural biology in the interest of the farmer, the stock breeder, the poulterer and the gardener ; but so far neither Governments nor individuals have come forward to encourage and subsidize research and observational experiment on man himself. The outstanding exception is Sir Francis Galton, who endowed the only chair of eugenics in Great Britain, now held by Prof. R. A. Fisher. The Weldon chair of biometry, now held by Prof. J. B. S. Haldane, is unfortunately limited by the proviso of the trust to "the higher statistical study of biological problems".

Research fellowships and studentships provided by bequest, trusts, and industry abound for physics, chemistry, engineering and the arts ; but in universities those reserved especially for the study of man as a social biological unit can be numbered on the fingers of one hand.

An analysis of the distribution of exhibitions, scholarships, studentships, fellowships, prizes and medals, from four universities, recently made by Dr. I. Frost, discloses that in a total of 346, three go to genetics or psychology, one to social psychology and ten to physiology. Fortunately, there are forty-three awards open to any subject, so that, as interest in those subjects affecting man attract the outstanding students, work in human and social biology can receive encouragement[6].

At present a degree in biological science at a university has to be in zoology, botany or the more specialized biological subjects such as medicine, agriculture, etc. There is no university course in social or human biology, while certain university courses in social science still ignore the subject. That this practice does in fact deflect attention from, rather than to, 'man' is shown by a demonstrator in zoology at a well-known university who deplored the lack of opportunity for the consideration of the human in his teaching and was told by his professor that he was "very daring" to use the human skeleton as a demonstration subject, and that it was "too dangerous" for him to include the human skull—this was 1941 not 1641. Under these conditions, a feeling has arisen among some zoologists and botanists that problems relating to man and his adjustment to environment are outside their purview.

At the end of last century and at the beginning of this, physics and chemistry had a struggle with the arts for *Lebensraum* in general education. The last few years have seen biology struggling with the other sciences for a share of the limited school time allotted to science. Educationists are still far from realizing that a general knowledge by pupil and teacher of the normal characteristics of man himself and some appreciation of the art of living should be fundamental to all education.

Social biology provides the basis for personal health and social relationships, and would enable a responsible democracy to create a social structure designed to enable man to attain his potential mental, emotional and physical stature. It was from the Empire and India that came the first appreciation of its importance. A special conference was held in connexion with the Imperial Social Hygiene Congress of 1930 from which memoranda, urging the introduction of the biological sciences to Colonial education, were transmitted to the Colonial Education Conference and to the Colonial Office Advisory Committee on Education. These representations were later supported before the Committee by Dr. W. K. Spencer and Prof. Julian Huxley and resulted in Prof. Huxley's tour of the African colonies. His subsequent report to the Government on "Biology and the Biological Approach to Native Education in Africa", and the publication of "African View", together with Margery Perham's outstanding work, marked real progress. The way was prepared for the guide to Colonial development provided by Lord Hailey's "African Survey".

In 1932 the then Prime Minister appointed a Committee on "The Education and Supply of Biologists", in which the importance of introducing the subject in home education was emphasized. The Hadow and Spens Reports brought science and the education of the adolescent under review. Authority now gives encouragement to nature study and biology but still hesitates to direct the attention of youth to the study of man and mankind as emphasized by Mr. L. J. F. Brimble in a recent address[7]. Of those who advance so far, many still believe that provided something be taught in school about man's capacity to breathe air and digest food, the major responsibilities, namely, those of reproduction and the integration of man's own personality, can be ignored.

In 1932 also, the National Conference on the Place of Biology in Education drew together educationists and biologists, who fully ventilated the question. A similar conference followed in Scotland. The Education Advisory Board of the British Social Hygiene Council gave permanent form to the movement. It has for nine years pressed the claim, first for time for general biology in the school curriculum, then that the biology taught should relate to man and extend to social biology.

Syllabuses for three alternative approaches up to School Certificate standard were prepared: from a basis of nature study, by Sir Arthur Thomson; from a basis of hygiene and physiology, by Prof. Winifred Cullis; and from general science, by Prof. Julian Huxley.

The results of the various efforts are reflected in the steady increase in biology shown by the School Certificate returns:

School Certificates

All Schools in England and Wales.

	1933	1934	1935	1936	1937	1938	1939–40
Biology ...	6,179	7,383	9,968	13,467	15,111	15,852	15,602
	9%	11%	14%	18%	20%	21%	22%
General Science	2,560	2,842	3,204	4,156	4,771	8,784	13,465
	4%	4%	5%	6%	6%	11%	19%

In the present emergency the demand is growing from teachers and education authorities for refresher courses on human biology and for short courses for 'school leavers' on simple social biology, but the need and the urgency is beyond present resources.

Under war conditions teachers of evacuated schools have many additional demands on their time and good will from the out-of-school needs of their pupils; some guidance to them on problems of psychology and social biology is badly needed.

Interest in social biology as applied to education is growing rapidly and war conditions demand effective action.

An attempt has been made to present a few practical instances, drawn from home and overseas, of failure to use existing knowledge, of lack of opportunity for those working in different fields to exchange experience, of opportunities missed for the application of biology to human welfare. The war effort is handicapped by man's emotional immaturity and biological ignorance.

It is suggested that a central organization for social biology should be inaugurated and that its first step now should be to evaluate existing knowledge and to consider methods of its application to current problems. The second, to invite the attention of universities, research councils, institutes and Government departments to questions meriting immediate research, observation and inquiry. The third, to promote constructive discussion in the re-interpretation of our social and spiritual values. The fourth, to act as a consultant body to governments, local authorities and professional bodies. The fifth, to provide information to responsible persons and to promote post-graduate teaching.

A number of groups are already interested in or concerned with application and research in one or more branches of human and social biology. For example, the departments of physiology, psychology and anthropology at the universities, the Medical Research Council, the National Institute of Social and Economic Research, the Royal Anthropological Institute, the Rockefeller International Board and certain philanthropic trusts.

In the practical application of social biology, the Eugenics Society, the Child Guidance Council, the Institute for the Scientific Study of Delinquency, the Nutrition Society, the British Social Hygiene Council, etc., are all doing a certain amount of the kind of work which should be given wider scope.

Concerned in the administrative measures with biological implications are the local authorities, through public health, education, public assistance and evacuation, magistrates, lawyers, probation officers, the medical profession and various departments of government.

Responsible for guiding public opinion are the Press, the Church, the educationists and the writers.

In Great Britain, a pioneer effort of a voluntary character has been the precursor of most national developments: from Drake and his privateers to the British Navy; from the Church schools to general compulsory education; from the friendly societies to National Health Insurance. A central organization having social and human biology within its purview might well blaze the trail for a national administration consciously directed to the improvement of human quality.

A national conference could, in the first instance, be convened to which all concerned would be invited in their individual capacities. The object would be the formation of an organization which would include the scientific worker in social biology and other social sciences at home and overseas, together with administrators and leaders in those fields affecting personal and social welfare. The sessions of the conference would be planned to summarize accepted factual knowledge, to indicate researches already perceived as desirable which could be promoted under responsible auspices and to stimulate the development of a positive philosophy of life satisfying to both intellect and emotions, embodying the ideal of man consciously directing his own progressive evolution.

From the conference, a small and active provisional executive could be charged with the task of appointing working committees, of forming a representative governing body, of seeking funds and of making initial plans for the co-ordination and presentation of research. In the case of social biology, consultative groups should be brought into existence without delay to advise on problems of emotional development and guidance, evacuation, juvenile delinquency, the care of the abnormal and sub-normal, preparation for marriage and marriage adjustment.

A panel of qualified lecturers would offer elementary and post-graduate courses in the social sciences; for example, in the case of social biology they could be offered to Civil servants and local authority officials and members, to magistrates and lawyers, to medical practitioners and the allied medical services.

Qualified lecturers could be nominated by the organization to participate in social science and other courses provided by the universities.

The committees concerned with research, with practice and with ethics would be in a position to submit questions needing analysis, observation or inquiry to the existing organizations equipped either to finance or to undertake the tasks.

Large funds for new enterprises, except for those directly related to war, or immediate post-war problems, could not be sought; but where the application of existing knowledge could materially increase the efficiency or reduce the human damage of the war effort—either safeguard or improve present or future human quality of physique, intelligence and character in the population—immediate action could be called for.

A number of the services suggested could be offered on an economically self-supporting basis.

To desire and seek truth and embody its wisdom in a plan of life is surely an ideal which will call out man's highest endeavour.

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[1] Local Government Directory, 1941, pp. 231–243. This excludes Home Office Approved Schools. (Annual Report of Ministry of Health, 1938–1939, p. 202.)

[2] Gen. Statistical Review, 1938. Table 1, p. 1.

[3] "The Social Distribution of University Education" by Prof. Major Greenwood. (*J. Roy. Statistical Soc.*, **102**, pt. III, 368 (1939)).

[4] "Labour Conditions in Northern Rhodesia", by Major G. Orde Browne. Colonial C.M.I. No. 150. (H.M. Stationery Office. 2*s*. net), 24, 25.

[5] "Labour Conditions in the West Indies", by Major G. St. J. Orde Browne. (H.M. Stationery Office, 1939), p. 70.

[6] This, of course, excludes the medical and surgical research opportunities—these with few exceptions are directed to disease, not even to preventive medicine or to the maintenance and promotion of positive health. Dr. Frost, medical secretary of the British Social Hygiene Council (in a personal communication), has analysed the data available in relation to the Universities of London, Liverpool, Manchester and Birmingham. The distribution of exhibitions, scholarships, studentships, fellowships, medals, prizes and research grants is as follows: divinity, 5; medicine (including dental surgery), 64; history and law, 36; art and architecture, 24; music, 1; teaching, 6; classics, 8; foreign languages (including phonetics), 27; journalism, 3; literature, 17; geography and geology, 6; mining, metallurgy and engineering, 42; archæology, 2; chemistry, physics, science, 51; mathematics and statistics, 12; physiology, 10; social science and economics, 22; commerce, 8; genetics or psychology, 3; philosophy, 2; zoology or botany, 5; open, 43; specifically social psychology (Graham Wallas Memorial scholarship), 1.

[7] NATURE, **148**, 787 (December 27, 1941).

IMPACT OF THE PHYSICAL SCIENCES ON SOCIETY

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THE *cause célèbre* of the Inquisition *v.* Galileo Galilei has often found mention in the columns of NATURE. In every recrudescence of the old controversy between science and religion it is as certain to crop up as King Charles's head in Mr. Dick's memorial, or as the burning of coffee berries at Costa Rica in a certain type of political argument, and with about equal relevance. The opprobrium showered on the instigators of that famous trial has been, perhaps, somewhat excessive. Their methods must be condemned—truth is not to be suppressed—but in their recognition that scientific discovery raises problems of vital import to society as a whole the Jesuit Fathers showed an insight into the potentialities of science which it would have been well if it had been shared by the statesmen of the past hundred years or so. The impact of discoveries in the physical sciences upon a society unprepared to receive them has led to an enormous increase in material wealth, but at the same time has raised a host of social, economic and political troubles from which the world is suffering to-day.

Though deplorable, it is not surprising that the far-reaching consequences of the work of the natural philosopher were not foreseen either by philosopher or politician. In spite of the often repeated statements to the contrary from upholders of a certain political philosophy, the discoveries in physics which have done most to change the face of society were not made with the conscious desire of meeting the material needs of mankind. Michael Faraday did not begin the researches which led to the discovery of electro-magnetic induction and issued in the present electrical era, in an attempt to improve on the Bunsen cell, nor did Sir J. J. Thomson discover the electron with the object of enabling the world to listen in to the B.B.C. Without in any way depreciating the painstaking and often brilliant work of the applied physicist, who, for very little reward, harnesses the principles of physics to the benefit—or destruction—of mankind, it remains true that the great revolutionary advances have been made by men who have had no motive except the undowered pursuit of truth in the natural world. The man who seeks for the love of the search will discover more than a man who is just looking for his collar-stud. Paradoxically enough, the first requisite for any further great progress in the application of science to the welfare of society is that the man of science shall be able to pursue his researches in absolute freedom from economic motive or State direction. Science in fetters will ultimately fail even in its ancillary duties as the handmaid of industry.

This being so, it is important if the disadvantages of the *laisser-faire* policy of the past are not to be perpetuated, that steps be taken now in preparation for dealing with the discoveries pregnant with new possibilities which are sure to come along. Research is always most difficult, though often most rewarding, in the no-man's-land which lies between the different sciences. It is likely to prove exceptionally difficult when the sciences differ as widely as physics and sociology: yet a liaison between the two is the most hopeful way of ensuring that the vast potentialities which the physicist is ever laying bare should be utilized for the welfare, and not to the hurt, of mankind. There is inevitably a pause, longer or shorter, between the discovery of a new principle, and its application. It is in this interval that direction and control can most easily be exercised. An excellent example of an opportunity happily grasped in time is provided in the control of broadcasting in Great Britain by the creation of the British Broadcasting Corporation. Instances where the opportunity was not seized may be left to the reader's own judgment.

The problems facing any central organization for sociological research are not, however, merely those of procuring a greater use of the unfolding powers revealed by the physicist. There are some possibilities which it might be wiser not to develop, and others where the application might be wisely delayed until necessary adjustments in our social organization had been made. An illustration, on a small scale, is provided by modern traffic conditions in our great cities. It is reported that the late Marquis of Salisbury would order his carriage and pair to await him in Downing Street ten minutes before his train for Hatfield was due out at King's Cross. It is doubtful whether a Secretary for Foreign Affairs just before the War could have cut the time of the journey so fine, although his modern car had some ten times the top speed of the Marquis's equipage. A more serious example of 'bad-timing' is provided by the whole history of the industrial era.

Almost every material problem is essentially a question of the proper utilization of energy; and practically every payment we make is directly or indirectly a payment for energy. Matter itself is indestructible, and though not unlimited in quantity, more than ample for our needs. Man's ability to gratify his desires on the material plane is limited only by the energy which he can control. It is for this reason that physics, which is the science concerned with the study of energy in all its protean forms, has played so large a part in the material developments of the past hundred and fifty years. Until the beginning of the scientific era man had to rely for his supply of energy mainly on his own body, aided by that of domestic animals and to some extent by wind and water. The advantage of the human body as a machine is, of course, its infinite adaptability. There are still, and probably always will be, operations for which its unique co-ordination of mind and movement is essential. The disadvantage is its running expenses, which, compared with other forms of energy, are very high. Electrical energy equivalent to that which a man can produce can be had for a copper or so a day. Steam-power, on a large scale, is even cheaper. Unless a man's time is worth less than a penny or so an hour any mechanical operation which a machine can be designed to carry out can be performed much more economically by the use of one or other of the newly discovered forms of energy. Therein lies the explanation of the enormous increase in material wealth since the beginning of the so-called industrial era. It has been estimated that the average citizen of the United States was, just before the War, enjoying amenities equivalent to those which in classical times would have demanded the services of thirty slaves. There is no reason to suppose that the process has reached or even approached its limits.

There is, as everyone knows, a reverse side to this encouraging picture. The scrapping of obsolescent machinery is economically sound, but if the machine happens also to be a man the results are extremely distressing. It is perfectly true that on the balance and over a period of time the introduction of scientific sources of energy has found employment for far more workers than it has displaced. New physical discoveries have formed the basis of great new industries, and more workers with a far higher average output are now employed than ever before. The change-over period is, however, bound to cause intense suffering, unless the changes can be foreseen, and plans worked out to ease the transition. Only by constant and co-operative study and research can this be ensured.

The introduction of new forms of energy has, moreover, introduced more permanent changes into the structure of society. When each worker was his own power unit his work could be carried on effectively anywhere. Those were the days of the master craftsman, and a man could be, and frequently was, his own master. Steam-power, the first to be introduced, requires for its most economical application to be generated in large units. Moreover, the prime cost of installation was high. Workers had to go to the machine, and the factory system sprang into being. The early evils associated with that system have been largely eliminated, partly by enlightened legislation, partly by the gradual realization, as a result of psychological research, that dismal and unhealthy conditions of working are inimical to high output. A modern factory compares very favourably in its amenities with the average university research laboratory. The scale of living of the factory worker to-day is far higher than that of the home producer of a hundred years ago, while owing to ancillary scientific inventions such as the radio, the cinema, and quick cheap transport his facilities for enjoyment have been greatly enhanced; and owing to cheap energy his hours of work reduced. So much lies on the credit side; and, as I have said before, the limit has not yet been reached.

If, however, we believe that man does not live by bread alone, not even by bread and circuses, there may be another side to the question which at least merits investigation. What, if any, has been the effect on the men concerned of transforming a number of at any rate semi-independent skilled artisans into a body of factory operatives? Assuming with Ruskin (a much discredited writer whom, I am told, few read to-day) that the true wealth of a nation lies in the quality of its individual citizens rather than in the mass of its material possessions, how does say five or six hours a day (supposing factory hours to be reduced to that number as they easily might be) spent in tending three or four automatic machines, or in any of the monotonous and mindless operations of a mass-production plant compare, from that point of view, with a somewhat longer daily period spent in an occupation where hand and brain are harmoniously employed together in the production of a finished article? Some preliminary research on these matters has been begun. Much more is needed. I would only add that should some decentralization prove to be desirable from a human point of view, the facilities are available to effect the transition without too great a loss of output. The transformation of steam into electrical energy has made the distribution of cheap energy to small production units an economically sound proposition.

The plea for the wider application of science in social affairs is often presented as if it were merely a matter of more research, and a fuller application of the results of research in everyday life. In the case of the biological sciences, from which direction the pressure mainly comes, this is undoubtedly true. Freedom from disease, an ample sufficiency of good food, and appropriate clothing are fundamental necessities, and the biologists do well to insist on their ability to satisfy them. One would like to define the task of the physical sciences as the liberation of man from drudgery, so that he might be free to develop and enjoy his higher faculties, of which his creative ability is not the least. Owing to the, perhaps not unnatural, emphasis which has been placed on the accumulation of material wealth, it is doubtful whether the sum total of the drudgery of the world, of labour in which it is impossible to take either joy or pride, has been substantially reduced, though hours of work have been lessened, and can be still further reduced as the potentialities of physical research are more fully applied.

It would, I think, be an error to suppose that under any system of planning the volume of fundamental discovery in physical science could have been much increased, or the pace of its application to social purposes profitably accelerated. It is direction rather than speed which has been lacking. New powers have been exploited without a full consideration of their remoter repercussions upon society. To take perhaps an extreme but poignant example, the destruction of the heart of Coventry was implicit in those few brief seconds for which the first aeroplane lifted itself from the ground, but no warning was given, or at any rate was not heeded until too late.

The question of what constitutes 'the good life', is one of philosophy and religion, not of science. A wise society will take from the treasure house of science whatever it needs for the furtherance of its purposes, leaving unexploited, or at any rate severely controlled, what might be harmful. Society, however, needs, and is entitled to, the best advice on the more immediate, and the more distant consequences of the use, or neglect, of the opportunities provided by scientific discovery. Neither physicist, economist, nor sociologist is competent alone for this task. A combination of the three might do much to direct the stream of progress into the happiest channels.

SOCIAL SCIENCE, STATISTICS AND POPULATION PROBLEMS

By D. CARADOG JONES

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THE vice-chancellor of one of our modern universities has been heard to state on more than one occasion that he has failed to discover what is meant by social science. In a lesser man that might be taken as lack of appreciation of a field of knowledge fraught with immense consequences to mankind; but in this case it was no doubt intended as a criticism of social scientists because they have not defined with any precision the boundaries between their own and other sciences. That is not surprising in view of the rapid development of interest in the study of sociology. Interpreted widely, as it should be, it would include any branch of knowledge concerning man regarded as a social animal, in short, the study of human groups. Although, for convenience of observation, individuals may be isolated, interest centres in their social behaviour, their relationship to other individuals similar in many respects to themselves. But the diversity between them, in temperament, in outlook, in aims, is of even greater importance than the likeness. It is these differences, if not delicately handled, that produce strains and ruptures—strikes, wars and revolutions—in the body politic. There is an attraction in superficial remedies for such conditions, but they do not last. We spend our energy too often upon the perfecting of the machinery of social life, while neglecting the source and spring of all motivization: it is like designing a car, stream-lined and beautiful in all its parts, only to find that we have no suitable fuel to make it run smoothly. One of the most fundamental of the social sciences is psychology, because it explores the nature and causes of the divergences between individuals in their innermost citadel where they are most intimately revealed.

Another fundamental social science is philosophy, which creates harmony out of an assembly of seemingly discordant voices. This is achieved by discovering the purpose of life and so relating a diversity of means to a single-minded end. The individual converted, the right leader found, it can turn a mob into a disciplined army; but the purpose of the army is not to wage war upon some other faction. This social philosophy is essentially moral: it takes all the world as its parish, for in the realm of science there can be no partisanship. The warfare will not be against flesh and blood, but against ignorance and disease of mind and body, a ceaseless campaign systematically waged to get the best out of the rich natural resources available for the well-being of all mankind.

Assuming the philosopher to have contributed his share to the shaping of the new world, the political scientist will next be called upon to design regional and international instruments capable of transmuting the philosopher's ideal plan into realized fact; the public administrator will assume responsibility for the right use and control of these instruments; and jurists will codify agreed rules to regulate social behaviour. As the curtain unfolds, the stage is seen to be set for actors almost without number, and each must play his part. The social historian warns us against the purchase of experience at too dear a price; he would have us profit by the mistakes committed in the past. The geographer deals with the reactions of human groups to their environment; it is his task to make an inventory of the raw materials latent in land and sea, to consider the most profitable use to be made of them, and to determine whether some areas are not too densely packed in view of their resources while others are starved of people to develop them adequately. Problems concerning the distribution and exchange of commodities come within the province of the economist; while the town planner contrives to apportion the land wisely to different uses, thereby preventing that haphazard building which has so frequently distorted the natural beauty of the countryside.

Hitherto we have failed to make a success of world government, not because we have lacked experts in all the social sciences mentioned, but because it has been nobody's business to survey the world as a whole and to co-ordinate the activities of these experts so that they work to a common plan. There has been another reason for failure: we have interpreted wealth in material terms and not in terms of human satisfaction. Economists and statisticians must take their share of the blame because, in comparing the standard of living of one class with another or the national income of one country with another, they have used money value as their measuring rod—with this much justification, that it seemed to be the only means of accurate measurement to hand. Yet, taken alone, it can be but a very imperfect index of what is really valuable in life. If we are to take true stock of a country's wealth, should we not start with the people who inhabit it? Apart from them, no other kind of wealth has sense or meaning.

So far this review has been in general terms. When we come down to practical details, we quickly discover large gaps in our machinery for making a satisfactory survey of the resources of even a small part of our own Empire, leaving other countries out of the account. Yet, to undertake such a continuous survey should be one of the main functions of the social scientist. Acting on the principle already enunciated, the most important feature of this stock-taking would be to trace the trend of population, in size and character. It was well known before the present War began that the population of Great Britain, in common with that of most other European countries, was fast approaching a decline, and the War itself will have gravely aggravated this condition. But population must always be considered in relation to the area occupied and to the stage of culture reached. With that in mind, the question arises—How shall optimum population be defined? And, having defined it, how shall it be achieved and how maintained? Clearly the optimum is not merely a matter of size. More important than their number is the quality of the people who inhabit any country. But quality varies from class to class, from individual to individual, and even from age to age in the same individual. Hence, as a first step towards a definition of the optimum, it would be well to try to assess the size and quality of the actual population at some given date, and to measure the effect upon it of a changing environment. Until such periodical assessments can be made over a sufficient interval of time, we shall be working to a large extent in the dark, lacking any standards or axis of reference.

How far do we take stock of the human wealth of the nation at present? The census provides us with a reasonably accurate count of the people every ten years, and enables us to classify them by location and by households. The population can also be split up into age groups, by sex, marriage condition and occupation. This gives us a photographic record at the date when the count is taken. In addition, day by day during intercensal periods, there is a legal obligation to register every new birth, marriage and death, and very few, in fact, escape registration. But, wasteful as it seems, these records have hitherto been kept in isolation from each other and from the census returns. There are, no doubt, administrative and other difficulties in linking them together, but these should not prove insuperable tasks.

Since every marriage starts a new family, the potential source of new wealth, and birth represents the actual creation, while death is the destruction, of human wealth, the State should keep as complete an account of these vitally important events as any efficient business firm does of its gain or loss of material goods, and should relate them to one another. This could be accomplished if, at every registration of a marriage or death, the law required the production of copies of the birth certificates of the persons concerned, and at every registration of a birth the production of a copy of the civil registration of marriage. It would be possible then to start a card index of each family at its foundation on marriage, and to keep it up to date by adding fresh records of birth, marriage or death as they occurred, until each member of the family, parents and children, passed out by death or started a new card by marriage.

The family, though the smallest, is undeniably the most important unit of social life, and these family cards, when analysed by random samples—drawn from different districts, or from different occupational groups determined by the occupation of the head of the household—would provide a rich mine of research material for students of social science. Important differences in marriage tendency, in fertility, in the incidence of mortality would come to light, and we should be in a much better position than we are now to say which sections of the community are contributing most and which least to the population of the future. Associated with individual identity-cards, such a scientific registration scheme could be used also to keep track of movement from one region to another, and of migration into and out of the country, as does the admirable system of registration which has been in use for some years in Sweden. No names, of course, would be disclosed; the material would be used solely for administrative and research purposes.

Periodical surveys should also be made of random samples of different classes of the population, in order to determine what is representative of each class—and the amount of variation from the average—in physique, nutrition, health, intelligence, temperament, character. In war-time the need for a detailed examination of the physique and health of all applicants to join the services is recognized as imperative. The need is no less in times of peace, but any such medical inspection is then confined in general to children of school age and those who take up certain types of occupation. In the task of establishing authoritative standards or norms of physique, nutrition, and health, by the analysis of selected random samples, the statistician will have to lend his aid to specialists in health and nutrition.

When we go on to consider the measurement of intelligence, our difficulties increase. The more important the quality to be measured, the less satisfactory are our instruments for the purpose. Some headway has been made in devising intelligence tests for the young, and we can certainly start by making as complete a survey as possible of the rising generation. But considerable research is still needed before we discover satisfactory devices for the assessment of temperament and character. Yet it is only when we reach the stage of trying to measure any such characteristic, however imperfectly, that we find ourselves impelled to seek to understand its true meaning and to define it in terms free from ambiguity.

Stress has been laid in this article on the importance of taking periodical stock of the population, because it is mainly in the people that the interest of the social scientist lies. But the people express themselves in their institutions and in what they make and do, so that our national stock-taking would be incomplete without a survey of all other forms of wealth. This opens up still wider vistas for investigation. The young hold the key to the future; we must therefore examine whether our educational system is such that we make the best use of the human material at our disposal. Pushing the inquiry further back—Is the training given to our teachers the most suitable for its purpose, and are they chosen in the best possible way? There is urgent need also to ask why, as man's capacity to produce grows, industrial depressions are intensified. What are the frustrations which prevent the free flow and exchange of goods and services? Are the ruling factors economic, dependent upon the improper adaptation of money to its purpose and the unwise handling of facilities for the creation of credit, or are they associated with selfishness, the power of monopoly and vested interests, possibly misguided even from the point of view of their own self-interest? Again, as opportunity for rest and recreation increases, are we learning to use it to better advantage? Under a machine economy the pace of work and of living generally is vastly accelerated. How is rest for the mind and for the nervous system to be obtained? Are these questions that can be settled by the medical man only or have they a psychological or spiritual basis?

So wide and intricate are the problems involved in any survey on the scale contemplated that the co-operation of experts in many fields would be essential to unravel them. A central research institute, if of independent status like a university, and adequately financed, would undoubtedly attract the services of distinguished men of science. It should have a permanent staff; but it should be able to enlist also the aid of other social scientists, whether in universities or associated with such bodies as have already been founded by private benefaction for the purpose of social research. In order to prevent overlapping and to secure comparability of results in all such inquiries, it would be the function of the central institute to encourage co-ordination and concerted planning. Along these lines it should be possible in due course not only to ascertain the value of our possessions but also to get some idea of the potential capacity of our people, and thereby to raise the general standard of living and national culture to a much higher level than we have yet achieved.

ETHICAL AND POLITICAL REMODELLING OF SOCIETY

By SIR FREDERIC KENYON, G.B.E., K.C.B., F.B.A.

THE rehabilitation of a wrecked and bewildered world will be the task of the years which lie immediately before us. In 1919 we hoped that we might restore the world as it was before 1914, with additional provision for its security. In 1942 we know that that attempt failed, and that when the present threat to civilization has been defeated it will be necessary not to restore an old world but to lay the foundations of a new one. A movement which has been in progress for a generation has been greatly accelerated. The foundations of society have been broken up. A new outlook on social relations has become necessary, and we have to orient ourselves in the new circumstances.

Up to the outbreak of the War of 1914–18 we were in effect living on the Liberal philosophy and political economy of the middle of the nineteenth century. Its corner-stones were individualism, *laisser-faire* and free trade; its prophets were Mill, Herbert Spencer, Fawcett. The State should interfere as little as possible. The individual should be left to develop in his own way; to buy in the cheapest market and sell in the dearest; to aim at material welfare and let the devil take the hindmost. It was a philosophy unimpeachable if once you accepted its fundamental axiom, that the whole duty of man is to cultivate material prosperity. Its best exponents recognized that the 'economic man', for whose conduct they enunciated principles, was not necessarily the whole man; but the politicians and the popularizers of scientific thought ignored this qualification, and for some three generations these doctrines governed the thought and the political practice of the nation.

There were always some—Carlyle, Ruskin and the Christian Socialists notably—who combated a political economy which they accused of being soulless. There were always some who maintained that, while unrestrained individualism was good for the strong and might bring wealth to a State, it involved unjustifiable suffering for the weak. A sense of social responsibility began to grow, and took visible form in the 'eighties, in such movements as the Salvation Army and the foundation of university settlements. Gradually, almost unconsciously, the State and the local administrations accepted more and more responsibility for the welfare of the people. The 'social services' assumed an ever-increasing importance in national and local budgets, which meant in fact that the larger incomes were curtailed for the benefit of the smaller. The War of 1914–18 intensified this movement; it gathered strength in the uneasy years of peace from 1918 until 1939; and with the new War it has come with a rush. The State has assumed control of nearly every form of activity. Large incomes are taxed to the verge of extinction. Hundreds of millions are drawn from the profits of individuals and companies and applied to keeping down prices for the poorer classes and increasing their earnings. The exigencies of war have brought us to accept, almost overnight and without a struggle, an almost complete measure of national socialism, and a very extensive levelling up and down of incomes. The problem now before us is, how much of this remodelling of society should and could be carried forward into the years of peace which will follow when once the forces of evil, with which we are engaged in a death-struggle, have been overcome.

The great danger is lest this problem should be approached under the old forms of political controversy, with the leaders of each party striving to stake out claims for those whom they represent, and to turn to their material advantage the opportunities of the moment. This, by whatever party it is practised —employer or employed, capital or labour, the 'haves' or the 'have-nots'—is war profiteering, the turning of the exigencies of war to one's own material profit. It may be more justifiable on one side than on the other; but the basis is the same, the nineteenth-century doctrine that everyone should do the best he can for his own material advantage.

The remedy needed is something far more fundamental. We have been so saturated with the doctrine that material welfare is the prime aim of life that we do not realize that it has not always been so. Material welfare has, no doubt, always been a motive of human action, and often a powerful one, but it has by no means always been the predominant one. It has not always been held that man lives for bread alone, or that "they should take who have the power, and they should keep who can". We know now to what the unrestricted application of this doctrine has led us. We want now to reconsider its validity, objectively and impartially, and to determine how it can be improved or replaced.

We want, in fact, a new political philosophy; and in this phrase the epithet is not used in the restricted sense of parliamentary and municipal controversies, "where ignorant armies clash by night", but in the sense in which "politics" means the art of living together in a civilized and organized community. This art has to be thought out afresh, and the thought needs to be as unimpassioned as possible. It is also of the first importance that the thinking and the formulating of its results should be done without delay, in order that the field may not be pre-occupied by the combatant politicians (in the narrower sense), and that the results of dispassionate thought may be at the service of the statesmen who eventually have to lead the reconstruction of our national life.

It is for this reason that the establishment of some form of central organization of sociology seems to many persons to be a desideratum. Just as the Institute of International Affairs serves a useful purpose in the collection of facts and the formation of opinion on international matters, and as institutes of archæology or chemistry or chartered accountancy bring together those who are interested in these subjects for the interchange of views, so a similar organization for sociology would serve as a forum for the formation of the new philosophy of social relations which seems to be needed. This is not so unpractical a proposal as it may seem to those who are satisfied with the limited vision of immediate controversy. It does not mean that long-bearded and unpractical scholars will sit down to elaborate paper constitutions or new Utopias. It means rather that those who are engaged in social activities will pool their experiences, will be invited to formulate their principles, and will be encouraged to work on a basis of co-operation rather than controversy, to see how much harmony can be achieved, not how much can be seized by force from an unwilling opponent.

For the operations of such an organization some guidance can be derived (as in so many other provinces of thought and science) from the Greeks. For Plato and Aristotle and their followers ethics and politics were intimately connected. The virtues of the State were the virtues of the individual, writ large. The social and political ideal of Aristotle is thus expressed by Mr. W. L. Newman:

"The State exists for the exercise of the qualities which make men good husbands, fathers and heads of households, good soldiers and citizens, good men of science and philosophers. When the State by its education and laws written and unwritten succeeds in evoking and maintaining in vigorous activity a life rich in noble aims and deeds, then and not till then has it fully attained the end for which it exists. The ideal State is that which adds to adequate material advantages the noblest gifts of intellect and character, and the will to live for their exercise in every relation of life, and whose education, institutions and law are such as to develop these gifts and call them into full play."

It is indeed the restoration of the connexion between ethics and politics that must be the principal aim of the new social philosophy. The whole tendency of political thought in the nineteenth century was to divorce them. Religion was excluded from the education given by the State, because religious dissensions divided the people so deeply. The current political economy deliberately excluded moral considerations, in order to concentrate on purely material considerations. In every department of life, in art and literature no less than in economics and politics, the intrusion of morality or religion was resisted. The economic man, not the ethical man, was made the basis of political theory, and material wealth was the goal of political practice.

The last hundred years have seen these principles tried out, and we are now in a position to estimate the result—a considerable amount of material success, leading to a moral *débâcle*. It would be the task of the organization proposed to study how the good can be separated from the bad; how freedom of the individual in thought and action can be made compatible with justice to all; how individual initiative can be encouraged without exploitation of the less fortunate masses; how the standard of life can be raised for the many without forfeiting the benefit which the whole community receives from the exceptional abilities of the few. We have been told that civilization has become mechanized; what it needs is to become moralized. We have before us terrible examples of the results of totalitarian control unrestrained by morality. We can see its efficiency, and we can also see its demoralizing effects. The new political philosophy must aim at securing the first without incurring the second; and this can only be achieved by the objective and dispassionate thought which an organization for sociology would cultivate.

We cannot afford to wait for an individual to give us the guidance which we need. If such a genius should appear, to be the Adam Smith or the John Stuart Mill of a new generation, it would be a godsend; but the need is urgent, and the ground can at least be prepared by co-operative effort. From such effort we may hope to obtain that philosophy of human affairs which Socrates, twenty-three centuries ago, declared to be necessary for the right conduct of life.

RESEARCH IN THE HISTORY OF SOCIOLOGY

By ALEXANDER FARQUHARSON

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IN any discussion upon the better organization of research in the social sciences in Great Britain the question of the place to be assigned to historical research will inevitably arise. This article leaves on one side the problems of the general development of research in social, economic and cultural history, and considers only the need for research in the history of the scientific study of society. The intimate connexion between that history and the general history of thought and of science will not be forgotten.

The history of the scientific study of society may be conceived in a wider or narrower sense. At its widest it may be taken as including all attempts throughout the history of mankind to present a systematic and consistent picture of the structure and development of particular societies and of groupings of such societies up to the limits of the known world. The work of Herodotus in the Hellenic world, of Ibn Khaldun in the Moslem world, and of Lord Hailey and his colleagues in the recent "Africa Survey"—to take three handy examples only—would fall under this definition. Research might deal with such topics as methods used (personal observation, second- or third-hand report, forms of record), models followed, the debt of each worker to what went before, a comparative study of interpretations of phenomena recorded.

A great part, however, of the work to be done would be in a field already occupied by historians as students of methods used and interpretations adopted in historical studies. An account of a society at a particular moment of time in the past has in general already won recognition as a source for its history, and in many cases has been subjected to an intensive critical examination[1]. Further, there already exist general critical accounts of such sources for particular epochs and territories, and also general accounts of the development of historical studies, the accumulation of material for these, and the growth of historical method.

The impossibility of separating the 'static' and 'dynamic' views of society becomes even clearer when pre-history and archæology are considered. The same material remains must be used in reconstructing either a picture of social conditions at a moment in the past or a panorama of social development from stage to stage. Further, this wider history must take account of theories of society, from Aristotle to Toynbee, and the critical work already expended on these by historians, philosophers and sociologists.

The historian of the scientific study of society must accept all this accomplished work as the foundation of his own. He has, however, something fresh to contribute, and that something is of extraordinary value. One aspect of it is the attempt to relate the historical outlook and methods of each epoch and its theories of society to the political and social structure and the culture of that epoch. The other aspect is the attempt to assist the re-shaping of historical studies to harmonize with the political and social structure and culture of the present and the immediate future. In Great Britain the latter task is already in hand; for historical studies in recent years have been notable for their reflection of current interest in social and economic problems; to-day the weight assigned to social, economic and cultural history is perhaps as great as that given to political history. Research in the history of the study of society would demonstrate insistently the relativity of historical study and the need for its continuous readjustment to social needs.

In its narrower sense the history of the scientific study of society would have in view only the period, once the spirit and outlook of science, and in particular the application of these to the study of human society, have gained recognition. Here again, a distinction must be made between a wider and a narrower field. The historical research now in question could be extended to cover all the social sciences, or it could be restricted to sociology in its more limited sense.

This distinction corresponds to an ambiguity in the definition of sociology long recognized and discussed by sociologists[2]. Among these it is generally agreed that sociology deals with such matters as social organization, social development and the relation of the individual to society, attempting always to sort out the more general tendencies observable in particular societies and in human society as a whole. Some sociologists, however, have put forward much larger claims. According to these, sociology is and should be recognized as a general theory of human society in somewhat the same sense as biology is a general theory of living matter; each of the special social sciences would thus fall into place as a department of sociological study. So far, however, this view of sociology has failed to establish itself, one main reason being that the methods used by the various social sciences have been distinct and in some cases difficult to reconcile. Many sociologists would, however, agree that the narrower and wider views of sociology are not antagonistic, that the narrower view may be appropriate as defining a useful field of operations for the present, and that the wider view should not be dropped altogether out of sight.

Leaning now towards the narrower view, the need for research into the history of sociology as a recognized department of study may at once be admitted. Descriptive histories already exist[3], but it would be possible to plan useful researches that would examine the development of sociology in a more fundamental way than has as yet been generally achieved. Such researches would deal not only with the chronological development of sociological studies, but with the conditions that influenced and directed that development in each country at each period. They might also deal with the circumstances of the life of each individual sociologist who has made a material contribution to that development, and the influences that helped to shape that contribution. They might further attempt to answer the question: What function was sociology as developed at a particular time and place expected to fulfil and did it actually fulfil—in other words, How did it fit into the general structure of society and of ideas? They might also shed light upon the ways in which sociology has been influenced by and has influenced thought and ideas in other fields. If such researches extended sufficiently far they would in time provide a sociological account of the development of sociology.

The value of such researches is not affected by the question that must arise when definite projects are discussed: Can such inquiries be usefully separated (except for temporary practical convenience in handling) from the general study of the history of thought and the history of science which has developed rapidly in recent years? It is clear that they cannot; indeed, the attempt to isolate the history of sociology would itself be unsociological, as it would put in the background or out of sight the environment of thought in which the central body of sociological ideas has developed and to which it has always been intimately related.

The project may be further defined. It has been said that, in place of a single sociology, there are to-day many sociologies, each an outgrowth of some national or sectional tradition; for example, American sociology, Catholic sociology, Marxian sociology. Researches might be planned which would exhibit the development of each of these sociologies in its relation to the tradition and social situation of the nation or section from which it emanated. (These might incidentally serve to reveal the elements that are common to those various sociologies however much they may differ in their selection and treatment of material and in their conclusions.) Such researches could not well be separated except temporarily from much wider studies. Catholic sociology is a part of Catholic thought; the Marxian view of society is an essential part of the Marxian system; American sociology is inseparable from the modern American social constitution and outlook. A body of researches into the various traditions in sociology would inevitably bring under review those larger fields.

If the wider view is taken and the need of historical research on the development of the whole body of the social sciences is considered, no fresh point arises. In the case of each social science we need more exact knowledge of its relation to the conditions under which it was born and grew. The influence of each upon the others is also a fruitful field of inquiry. It is probable that such historical research might bring more clearly into view and define more exactly the differences in outlook and method that now separate the various social sciences so much more widely than is required by practical convenience. It is possible that the fuller understanding thus developed might help towards the co-operation and co-ordination of these sciences. It would, however, be inappropriate to pursue the topic here.

There is one further subject upon which research into the history of social science should throw some light. My old teacher, Victor Branford, used to say: "The difficulty about the acceptance of sociology in a particular society (*e.g.*, English society) does not lie in its ideas, which are simple, but in the lives of those who cannot accept it." By this he did not intend to suggest the possibility of some facile and universal use of sociology as a guide in the common affairs of life; he meant that the attitude proper to the sociologist—open-mindedness, endeavour to discover root causes, sympathy with persons of different age, culture and education—was extremely rare; or, more generally, that what he would have called a scientific attitude in and to social life had gained little recognition and acceptance. The fact will scarcely be disputed by those who have given serious thought to the subject. It has an important bearing on the development of sociology in the future, and it might be made the subject of a plan for intensive historical and contemporary research, to form part of an inquiry into the general attitude to scientific method and scientific results which now limits all scientific development.

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[1] For example, the "Domesday Book".

[2] On the scope of sociology, see Ginsberg, "Sociology" (Home University Library).

[3] For example, Sorokin, "Contemporary Sociological Theories".

REVIEWS

DECLINE AND REVIVAL OF ACID-BASE CATALYSIS THEORY

Acid-Base Catalysis

By R. P. Bell. Pp. viii+212. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 12*s.* 6*d.* net.

THE establishment of a new truth invariably evokes a number of new fallacies; the brighter the light that a new theory sheds on its proper field, the darker, and the more distorting, the shadows in which it submerges the experience which lies around the borders of its true scope. The striking success of the theory of electrolytic dissociation based on mass action law blinded scientific workers for more than twenty years to the necessity of invoking a new principle for the explanation of the marked deviations from this law in solutions of neutral salts and strong acids and bases.

An equally paralysing orthodoxy, which also had its origin in the earliest classical period of physical chemistry, was the strict separation between the problems of chemical equilibria and chemical reaction rates. It was the pride of the physical chemist to be immune against the tendency of the ordinary chemist to confuse the two fields, and he felt it to be his mission to emphasize on all occasions that the problems of chemical reactivity could not be dealt with by reference to thermodynamics. This prejudiced his mind against taking proper notice of parallels between reactivity and equilibrium constants, where such parallels did exist.

The inquiry on which Dr. Bell reports in his book has gone on continuously for the last fifty years and is still concerned with the questions which were foremost in the minds of van t'Hoff, Arrhenius and Ostwald at the birth of physical chemistry. Nor are the new solutions to these problems due to any considerable extent to the incursion of more recent ideas from other fields; the modern theory of strong electrolytes, the recognition of the primary and secondary salt effects, the generalization of the concepts of acids and bases and the discovery of Brönsted's law do not borrow important elements from outside the original domain of van t'Hoff and Arrhenius. These successes were rather due to the efforts of that unusual type of originality, which—resisting the temptation of glittering modern openings—continues to cultivate a shadowy field, considered by others as exhausted and ossified, and finally breaks the ban of orthodoxy and revives the fire of the original problems by insisting on fresh intuitions gained from a new contact with the experimental material.

Such was the quality of the minds which renewed the study of electrolytes and of acid and base catalysis during the past three decades. Among these, preeminent was J. N. Brönsted, to whom Dr. Bell pays a personal tribute in the introduction of his book, and to whose work much of the material collected in it is due. Another considerable part of this material is supplied by the author's own research work, through the pursuit of which he has gained that remarkable insight which guides his treatise through all aspects of the subject. These aspects are varied and can often be properly assessed only by a careful analysis of the chemical system and the prevailing experimental conditions, viewed in relation to a many-sided theoretical framework. A fair amount of such detailed discussion lends the book more the character of a critical report than that of a textbook. However, this makes it only the more useful to the advanced student, for whose use it is intended.

In the last few years before the War a number of attempts were made—in which Dr. Bell took an active part—to explain Brönsted's relation in terms of the atomic forces at play in the course of proton transfer. Dr. Bell's evaluation of these efforts will be most helpful to future investigators in this field. He points out the present gaps in the theory which look almost fatal, and yet asserts, and explains why, "it is difficult to believe that [it] does not contain the elements of the true explanation". He recognizes the limitations of the transition state theory, in particular where the activation energy of the reaction varies with temperature, yet makes good use of it for elucidating the general relationship between reaction rates and corresponding chemical equilibria. A chapter on "non-mechanical" proton transitions (tunnel effect) adds another field where a loosely fitting theory requires and seeks more substantial evidence. The open questions are again candidly discussed, yet the essential value of this line of investigation is effectively vindicated.

I was somewhat astonished to find no reference to such matters as G. N. Lewis's conception of proton-free acids; or Frumkin's connexion between Tafel's equation for the over-voltage of hydrogen and the laws of acid-base catalysis. But perhaps such omissions are required by the rigorously concise plan of the book, which reflects so truly the internal harmony of the curiously self-sufficient province which forms its subject.

M. POLANYI.

HISTORICAL GEOGRAPHY—THEN AND NOW

Geography and World Power

By James Fairgrieve. Eighth and revised edition. Pp. viii+376. (Bickley, Kent: University of London Press, Ltd., 1941.) 7*s.* 6*d.* net.

DURING the present century the subject of historical geography has developed from rather crude efforts to show how geography has influenced the course of history to the study of the use of possibilities by man in successive ages. Mr. Fairgrieve's book belongs to the earlier period, although its author has attempted to avoid obviously determinist doctrines by his definition of the word 'control'. "When we say", he writes, "that 'history is controlled by geography' we do not say that man is compelled by geography to use more and more energy, but that the precise way in which he has come to do this is largely controlled by his environment."

When one passes from the introduction to the main body of the book one realizes that the author has not wholly escaped from the contradictions inherent in the determinist view. The sea is "one of the great features whose power of protection has affected the world" (p. 21). But later (p. 329) examples are given of eleven powers which "have had sea power or ocean power depending, some almost entirely, others to a less extent, on the ease, cheapness and certainty of water carriage, and on a certain knack of the sea, bred of familiarity and use". It is strange to reflect that in 1941 the lesson has not been learnt that it is the British Navy, and not the sea, which has provided the "power of protection" to Great Britain and many another land. The disadvantage of Mr. Fairgrieve's interpretation of geographical control may be seen in his attempts to keep pace with the activities of man. In 1920, so great had been the material efficiency of Germany that "almost the united strength of the whole world" was required to overcome it. Yet "though the conflict ended as it did, that does not alter the geographical position of Germany nor the characteristics of her people". (2nd Edition, p. 224). Surely, then, one would have expected a warning that the War of 1914–18 would be repeated as soon as that "material efficiency" was again strong ? But Mr. Fairgrieve is no prophet : he remarks, in the present edition, that "material efficiency . . . has been the cause of war, and we should be rash to conclude that a final fixed state has been reached, for there has been no alteration either in the geographical position of Germany nor [*sic*] the characteristics of her people". Is this a real warning to us of the inevitability of events ? If so, it ought to be pressed with greater vigour.

Any writer who attempts to deal with world history and world geography in all ages in less than four hundred octavo pages invites criticism even if he does not deserve it. It is possible to quote many misstatements, or at least to express doubts on many of the positive assertions that are made. Thus the statement made in 1920, and repeated verbatim in 1941, that the sea-powers of France, Italy, and Portugal are "in league with Britain" scarcely expresses the facts. Magellan never "sailed round Cape Horn" nor did Napoleon "keep all his troops in the north" of Spain in the Peninsular War. One cannot readily accept the implications of many of the sketch maps nor appreciate the value of arrows liberally supplied on many of them. Yet the fact that this is an eighth edition of Mr. Fairgrieve's book must be taken both as a measure of the popular appeal of the subject and as a tribute to the author, whose pioneer work in geography should never be under-estimated.

J. N. L. Baker.

ROMANTICISM AND SCIENCE

Natural Science in German Romanticism

By Alexander Gode-von Aesch. Pp. xiii + 302. (New York : Columbia University Press ; London : Oxford University Press, 1941.) 20*s*. net.

HISTORIES of German literature usually distinguish a Romantic School of writers whose activities began in the closing years of the eighteenth century and continued until the fourth decade of the nineteenth century. The more obvious characteristics of these authors consisted of a certain antagonism to classical antiquity and to rationalism. They preferred the medieval and the mystical. They glorified the German past, and they fostered German nationalism and State-idolatry, the bitter fruits of which the world is now tasting, and not for the first time. More or less intimately associated with the Romantic School were certain famous philosophers—the brothers Schlegel, Schelling, Schleiermacher, and the arch-totalitarian Fichte. In the circumstances it was to be expected that German Romanticism would not be lacking in world-views of some sort. To find any unity or harmony in these world-views would be rather difficult in any event ; and Mr. Gode-von Aesch has increased his difficulties by including in the German Romantic movement some writers, like Goethe, Herder and others, who are not usually regarded as belonging to it. Sometimes, indeed, he seems to wander away altogether from the historic Romantic School, and to discourse about a Romantic world of thought without specific reference to individual representatives. At times, in fact, the reader gets the impression that the author has put together in his volume a number of separate essays which are not sufficiently interconnected to constitute a systematic exposition of the theme designated in the title of his book.

The speculative ideas embraced by the various representatives of the German Romantic School showed no originality. They were all taken over from ancient philosophy or medieval theology. Pantheism or panpsychism, the conception of man as a small world (microcosm) or of the world as a kind of colossal man (macroanthropos), the idea that love is what holds the universe together, and so on—these are all old thoughts ; and they are not made either better or worse by being put into verse. This does not necessarily detract from the merits of the German Romanticists. It is no mean achievement on the part of literary men to give effective expression to world-views, even if they do not originate them. In the volume under review the philosophical speculations of many more or less Romantic authors are described, illustrated and analysed with some critical acumen ; and all those who are interested in the study of German Romanticism will find much helpful material in this book. If its title had been "Philosophy in German Romanticism", its contents would have been described accurately, and no reader could have complained with justice that he had been led to expect something different.

The prominence given to "Natural Science" in the title of the volume is unfortunate. Of science, as the term is commonly used in English-speaking countries (that is, knowledge based on verification by experience), there is next to nothing in the thought of German Romanticism. Scientific terms like magnetism, gravitation, etc., it is true, occur with considerable frequency ; but they are usually associated with non-scientific speculations, not to say extravagant fancies. Thus, for example, we are told that "animal magnetism proves beyond a doubt that we have . . . a soul which consists of the divine spark". Again, the attraction and repulsion of material bodies are identified with love and hate ; and Empedocles is consequently proclaimed to have anticipated Newton. But it is unnecessary to multiply such examples, since it is admitted that "German Romanticism excelled in taking seriously all sorts of absurd quackery". In a sense, of course, there is plenty of romance in the history of science ; but romancing is not science ; and it is rather misleading to refer to such romancing as "Natural Science". In this connexion it may interest the author to be informed that, contrary to his assertion, Newton did *not* refuse to theorize about the causes of gravity ; what he did refuse was to regard such unverifiable speculations, including his own speculations, as a part of science.

A. Wolf.

NEWS and VIEWS

H.R.H. The Duke of Connaught, K.G., F.R.S.

By the death, on January 16, at the age of ninety-one, of the Duke of Connaught, the Royal Society has lost its senior Royal fellow, for he was elected so long ago as 1906 under the rule which permits of the election of "Any one of His Majesty's subjects who is a Prince of the Blood Royal". Apart from this distinction, the Duke was probably best known to scientific men as the president for many years past of the Royal Society of Arts, in the activities of which he took a keen interest. He was also president of the Royal Colonial Institute, a fitting acknowledgment of his statesman-like services as governor-general of Canada and on other missions to various parts of the Empire. His work as a public servant will go down in history as an important link in the chain which binds together the peoples of the British Commonwealth of Nations.

Letter from Sir William Hooker

Prof. J. Walton, regius professor of botany in the University of Glasgow, has recently acquired a letter (the text of which follows) written by Sir William Hooker, the well-known British botanist who was regius professor of botany at Glasgow during 1820–41, after which he was appointed director of the Royal Botanic Gardens, where he was followed by his equally illustrious son, Sir Joseph Hooker. The letter was written from Halesworth to Mr. Morris Pollock of Glasgow, on September 22, 1820. Prof. Walton informs us that it will be preserved in the University of Glasgow; he does not know whether the silver vasculum referred to still exists. The corrections and mis-spellings are as in the original manuscript.

"Let me beg of you to accepet for yourself & to offer to the rest of my friends, the students of my first years Claſs my sincere & grateful acknoledgements for the very beautiful Silver vasculum & the kind expreſsions of regard for me & my family contained in the addreſs therein inclosed, which have reached me this morning.

"The truly elegant box with its appropriate ornaments is greatly inhanced in value in my estimation (though this I feel to be intrinsecally far beyond what I can deserve) by the handsome manner in which it has been presented to me, & by a recolection of the smalneſs of the Claſs from whom I received it. Be assured that though I needed no token of your regard to urge me to exertion in the duties of my profeſsion in the University of Glasgow, I nevertheleſs have felt a gratification in receiving it which I know not how to expreſs, & which will render my return amongst those who have taken such an opportunity of showing their friendship for me & interest in my welfare doubly agreeable to me.

"I am still labouring in the cause of Scottish botany in the preperation of a Flora of your country which will be published before the commencement of my next years course. The occupation continually brings to my recollection plants that I have long ago gathered amidst the most delightful scenery, & which I little thought would have been turned to any account.

"Once more let me return you my sincere thanks for the most gratifying gift I ever received in my life, & through you let me offer to my other students the expreſsions of my acknowledgements & the affectionate attachment with which I have the honor to be, My Dear Sir your & their most oblidged & faithful friend & servant Wm. J. Hooker"

Regional Propositions for Tyneside

The second edition of Mr. D. M. Goodfellow's "Tyneside: the Social Facts" (Newcastle-upon-Tyne: Co-operative Printing Society, Ltd., 1941. 1*s*.) includes two further chapters on "Regions and their Planning" and on "Regions: the First Facts", which are relevant to the discussion of the regional propositions in the recommendations of the Royal Commission on Local Government in the Tyneside Areas, adoption of which in the main was recommended in the original edition of the pamphlet. The first of these new chapters reviewing the operation of the Town and Country Planning Acts in practice, suggests that the real difficulties in Tyneside are not due to problems of compensation but to the multiplicity of authorities. Territorial planning is a means for reviving and developing the manufacturing and agricultural industries of the area, but these positive purposes will never be realized with the present authorities, and in the second new chapter an area comprising the geographical counties of Durham, Northumberland and the North Riding of Yorkshire is proposed as a possible unit which might come to be defined as a local government region. Such an amalgamation would be a very different matter from one based upon the Mersey, Manchester or Birmingham, but amalgamations are probably most difficult where they are most urgent. However desirable the formation of regions may be, it would not of itself automatically solve all the problems.

A New Form of Government

In his pamphlet "A Sling against the Philistines: the New Machinery of Government by the People" Denis Becker (London: Andrew Dakers, Ltd., 1941. 9*d*. net) proposes the establishment of a Ministry and Court of Enlightenment as a means of freeing Parliament and Ministers from the influence of financial and other interests which stultify representation in Parliament and threaten the freedom of the Press. The Court of Enlightenment would consist of nominees of each of the principal universities, of the learned associations such as the Royal Society, the Law Society, the British Medical Association, the Headmasters' Conference; of each of the established royal societies devoted to the arts, such as the Royal Academy of Music, the Royal Society of Arts, the Royal Institute of British Architects; of each of the recognized ecclesiastical bodies; of the agricultural associations, of the Trades Union Congress and of the Employers Federation, with two or three nominees by the House of Commons and the House of Lords of outstanding members, two nominees by the Prime Minister of eminent men not connected with the institutions already specified, and a nominee of His Majesty's judges who would be *ex officio* chairman.

The nominees would be freely elected by the members of the institutions concerned at intervals not exceeding three years, and the Court so constituted would be charged primarily with the duty of advising the Prime Minister on the promotion of welfare and culture with special reference to the best use of the rising standard of knowledge, technique and scientific discovery. It would be responsible for the control of the B.B.C. and of the Ministry of

Education, and, through it, with the provision of the best form of education for the new generation, and also for the publication of a State newspaper. Mr. Becker further proposes that all Parliamentary debates should be broadcast in full on a separate wave-length, and he proposes new parliamentary methods. He claims that his proposals harmonize the three estates of sovereign power, represented by the people, executive power and the power of the mind; but he emphasizes also the need for a spiritual basis if any new machinery is to work successfully.

Inter-American Relations

THE U.S. Office of Education is publishing a new series of some twenty pamphlets under the general title, "Education and National Defence", with the purpose of assisting educational institutions and organizations to make the greatest possible contribution towards the promotion of understanding and the encouragement of effective citizenship. Pamphlet No. 13 in this series, "Hemisphere Solidarity", is a teacher's guide on inter-American relations with special reference to Latin America, designed for senior high schools, to assist a better understanding of Latin-American neighbours and their contribution to the welfare of the western hemisphere as well as to stimulate thought on vital problems affecting mutual co-operation among the nations concerned. In addition to a discussion of methods of teaching hemisphere solidarity, it includes a suggested outline of problems and activities and a useful bibliography on sources of information.

Sir Charles Parsons and Turbo-driven Fans

THE Christmas issue of the *Heaton Works Journal*, which deals with the activities of Messrs. C. A. Parsons and Co., Ltd., contains an article on early turbo-driven fans. In 1894, when Sir Charles commenced his experiments on turbo-driven centrifugal pumps, he constructed the first turbo-driven fan. This was to the order of Ramage and Ferguson, Ltd., of Leith, who fitted it on board the S.Y. *Speedy* for supplying forced draught to the boilers. The unit was a very small one, the turbine developing about 3 h.p. at a speed of 4,000 r.p.m. The fan was of the screw propeller type, but no particulars of its duty or its dimensions are to be found among the records at Heaton Works. In the following year Sir Charles took out a patent, No. 3024, covering "Improvements in Stationary and Portable Pumps Actuated by Steam Turbines". The first part of this patent deals with turbo-driven centrifugal pumps, while the latter part is devoted to turbo-driven fans. The first of the figures given shows a modification of his invention in which he applies the turbine directly to a screw fan for forced draught, or ventilating purposes. One of the steam turbines is directly coupled to the fan shaft upon which the screw fan is fixed. It revolved at a speed of 2,000–3,000 revolutions per minute, gave a pressure of 12–22 in. of water and delivered 5,000–7,000 cu. ft. of air per minute. Simultaneously the second turbo-driven fan was constructed for the lead works of Messrs. Cookson and Sons at Howdon-on-Tyne. Like the first fan, it was required for forced draught purposes. The turbine developed 60 h.p. at 3,000 r.p.m. and operated with steam at 80 lb. pressure. The fan, which was 36 inches in diameter and directly coupled to the turbine shaft, delivered 60,000 cu. ft. of hot lead gases per minute at a pressure of 5 in. of water when running at 3,000 r.p.m. The plant was run for nearly seven years day and night (Sundays included) in hot lead fumes, at a temperature of nearly 500° F. and was only stopped twice a year, to allow of the flues being cleaned out.

Octonarian Weights and Measures

IN "Octonaria" (*Math. Gaz.*, October, 1941) "Peter Simple" gives, in an account of an imaginary State, what is really a plea for a system of numeration and weights and measures based upon eight instead of ten. It is urged that continued divisibility by two is a property of the greatest importance. For example, the seven weights, each double the last, of 1, 2, 4, 8 ounces, and 1, 2, 4 pounds will make up every weight, to the nearest ounce, up to 127 ounces, whereas with the seven metric weights 1, 2, 2, 5, 10, 10, 20 grams, we get only as far as 50 grams. Some of the existing British measures fit easily into the octonarian system. For example, 8 pints = 1 gallon, 8 gallons = 1 bushel, 8 bushels = 1 quarter. As for money, if the crown (one eighth of £2) were divided into sixty-four pennies instead of the present sixty, each new penny would be fifteen sixteenths of the old.

The further proposal to have an octonarian system of numeration is more startling. In this, 10 would denote eight, 20 twice eight, 100 eight times eight, and so on. It is obvious that the risk of confusion would be very great, and the author's suggestion that 20 should still be called twenty, although denoting twice eight, seems to be a gratuitous increase of this risk. The plea that this system would reduce the length of the multiplication table does not seem a sufficient recommendation. The duodecimal system, which has many advocates, as allowing division by three as well as by four, is rejected by the author on account of the extended multiplication table necessary. There is one possibility not mentioned in this paper. If the octonarians and duodecimalians press hard enough, the British spirit of compromise may split the difference between eight and twelve and adopt a decimal and metric system.

Luminous Paint

IN NATURE of November 1, p. 529, reference was made to luminous strontium sulphide and its possible use for A.R.P. purposes. Dr. S. Rothschild points out that although this substance has a long afterglow when fresh, owing to its great sensitivity to moisture it soon deteriorates, even when protected with a special coating. It is only stable when kept airtight between glass plates and to a certain extent when embedded in plastics. Luminous calcium sulphide is less sensitive to moisture but also less bright. Luminous zinc sulphide, however, is stable even in damp rooms and is now obtainable with an afterglow sufficient for A.R.P. purposes.

A similar luminous effect can be obtained by illuminating a fluorescent substance with the appropriate radiation. The B.A.B. fluorescent system of lighting (Colloidal Research Laboratories, Ltd., 66–70 Petty France, London, S.W.1) has been applied successfully to mark the approaches to Piccadilly Underground Station and elsewhere. The fluorescent substance is applied in the form of hard wearing lacquer on a white undercoat, and is illuminated by either a mercury vapour or a white light lamp fitted with a 'black glass' screen which is claimed to pass only the band 3340–4000 A., thus absorbing the dangerous radiations of shorter wave-length.

Health of Tanganyika

THE chief points of interest in the recently published annual report for 1939 of the Medical Department of Tanganyika Territory are the plans for the development of a native medical, nursing and public health service. The War has interfered with plans for nutritional investigations and relief for deficiencies, although a start has been made. As regards the incidence of various diseases the most important facts are as follows: the discovery of two fresh foci of sleeping sickness (663 cases with 184 deaths), cerebrospinal fever (2,183 cases with 237 deaths), the discovery of a plague-infected rat, and an investigation of smallpox. 248,533 cases of infectious and parasitic diseases were reported from various Government institutions. The most frequent diseases were as follows in the order named: yaws, malaria, syphilis, ankylostomiasis, gonorrhœa, schistosomiasis and tuberculosis. The population of Tanganyika in 1939 was: Europeans 9,165, Asiatics 33,974, and Africans 5,217,345.

The Completed Map of North East Land

ALTHOUGH North East Land, the most easterly island of the Spitsbergen group, was known to the seventeenth-century whalers, it was relatively unexplored until some twenty years ago, except for an attempt by A. E. Nordenskjöld in 1873. The modern survey, begun by the Oxford University Expedition of 1924, was virtually completed by the Oxford Expedition of 1935–36, though some important work was done by the Swedish-Norwegian Expedition of 1931. The map published in the *Geographical Journal* of October 1937 is now revised in some minor and one major point by a new map in the *Geographical Journal* of October 1941 (A. R. Glen, "The Latest Map of North East Land"). This map makes use of the Norwegian aerial surveys of North East Land in 1938 which are not now accessible, and it shows one remarkable change. In the south a great lobe of the South Ice has overridden the coast on a thirteen-mile front and pushed ten miles out to sea. Recent investigations show that the ice of North East Land is in the main in retreat: small ice-free areas have been found on the east coast. This advance is probably purely local, and Mr. Glen suggests that it may be due to a tectonic disturbance or some internal glacial cataclysm. The whole surface of the ice lobe is heavily crevassed.

National Central Library

THE twenty-fifth annual report of the executive committee of the National Central Library for the year 1940–41 refers again to the special war work of the Library for Government departments, research stations and industrial concerns, as well as to the service organized in co-operation with the county libraries and the Scottish Central Library for Students, for the supply of educational books to men serving in the Army in all parts of the British Isles. A similar service has been given to men serving in the Royal Air Force, and the Library has also been able to assist men serving in the Royal Navy and in the Mercantile Marine through the agency of the Seafarers' Education Service. At the request of the Home Office, the Library has organized, with the assistance of the local urban or county libraries concerned, a service for the supply of educational books to aliens in internment camps. The Library has acted as agent of the American Library Association's Committee on International Relations in connexion with the distribution of American books and periodicals to men serving in the British Forces at home and overseas. With the assistance of the British Council, the Library has also been instrumental in supplying books in their own language to sailors, soldiers, airmen and civilian refugees from Czechoslovakia, Greece, Holland, Poland and other Allied countries now in the British Isles.

When the Treasury grant in aid to the Library for the year 1940–41 was reduced from £4,800 to £3,500, the trustees of the Rockefeller Foundation made an emergency grant of 8,500 dollars for the year 1940–41, and the Foundation has continued to provide money for the upkeep of the Bureau of American Bibliography. The trustees of the Carnegie United Kingdom Trust continued their grant of £4,000. The total number of books issued during the year decreased from 50,611 to 39,420, issues to university libraries being 2,433 as against 3,046 in the previous year; of these, 1,100 were supplied by university libraries themselves.

Museum of the Royal College of Surgeons

THE scientific report of the Royal College of Surgeons for the year 1940–41 states that the Museum and store rooms were hit during an air raid, incendiaries increased the damage, falling girders broke up the basement below, and heavy rain the following days drenched the exposed specimens. The loss, though serious, was not complete. In the anatomical series 1,207 specimens survived out of 2,569. In the osteological series, out of 1,655 Hunterian specimens only 94 were saved, and 6,209 of 15,545 College specimens. On the other hand, the whole of the odontological series was saved. Nearly half the 5,400 Hunterian physiological specimens escaped, but only 2,026 of the 14,850 College specimens in this series. Of the human and comparative teratological specimens only 23 of 170 Hunterian specimens remain, but the College specimens have largely survived. The better part of the Hunterian pathological series remains, but the College specimens have been reduced to about a fifth, and the whole of the Townbee and Strangeways collection has gone; the Army Medical War Collection has been reduced from 3,000 to 100. All the mummified specimens and the historical collection are lost, and the instruments collection has been reduced from 2,500 to 2,000. The zoological and anthropological pictures have survived, including Tonks's war pictures. The total loss of specimens amounts to 39,259 out of 65,827.

Vacation Apprenticeship Scheme

THE value of practical training, and of a close linkage with industrial practice during the undergraduate years, is receiving more and more recognition in scientific academic circles to-day. This is the case, not only in the engineering faculties, but also in branches of pure and applied science—chemistry, physics, and even biology. That this is also appreciated and valued by industrial firms themselves is apparent from the steadily growing success that has attended the Vacation Apprenticeship Scheme carried on by the Imperial College Union for the benefit of students of all departments in the Imperial College of Science and Technology. From its inception seven years ago, the scheme has shown a steady record of progress in spite of the uncertainties of the past few years. In the summer of 1941, for example, 124 firms accommodated 181 students, granting them the opportunity to receive valuable experience in many of the experimental and production processes. The reports of the firms and of the students show how well and how smoothly the scheme is working. It is significant in this connexion that since the inception of the scheme, the average earnings per student reached its peak in 1941. During the summer vacation, July–September, 1942, more than three hundred students of the Imperial College will be available for varying periods of from six to eight weeks, and there is evidence that the co-operation of industry is likely to expand with this growing demand for absorption.

The Linnean Society of London

THE Linnean Society of London is now holding some of its meetings (those of zoological interest) in conjunction with the Zoological Society of London. The Society has decided to invite by name botanists and zoologists who are refugees in Great Britain to attend the general meetings of the Society. If, therefore, any such botanists or zoologists will make application to the Assistant Secretary, the Council will consider the issue of invitations to attend the meetings.

The following discussions are being arranged by the Society: (1) "The biogeographic division of the Indo-Australian Archipelago; criticism of the Wallace and Weber lines, and of any other dividing lines, with an attempt to obtain uniformity in the names used for the divisions". The subject will be introduced by an account of the geological history and climates of the Archipelago, by Mr. J. B. Scrivenor, lately director of the Geological Survey, Federated Malay States (in April); (2) "Time, temperature and humidity in the germination of seeds", to follow an address on "Recent work on germination", by Dr. M. A. H. Tincker (on May 14); (3) "Intertidal zonation of animals and plants", introduced by an address on "The causes of the zonation of animals and algæ between tide marks", by Prof. T. A. Stephenson (on June 18).

Broadcasts on the Sub-visible Universe

A SERIES of twelve talks under the title "Science Lifts the Veil", which deals with the structure of matter, is being given on Mondays in the Empire programme of the British Broadcasting Corporation. The talks, which were introduced by Sir William Bragg on January 5, have been arranged with the advice and assistance of the Science Committee of the British Council. Sir William Bragg explained the idea and significance of the theme. He pointed out that the growth of science and of its power is largely due to an increasing ability to see or recognize smaller and still smaller things. The range of the unaided eye is limited, and it has been natural to ignore what cannot be seen. The microscope opened the way to more thorough knowledge; other means have been developed in succession. As each fresh veil has been lifted from the regions of the sub-visible universe, a new range of knowledge has been revealed, and this has in many cases provided mankind with new powers over materials, life and health. The talks, which are being given by leading men of science, will explain the revelations that have come with the magnifying glass and the microscope, X-rays, the electron-microscope and other aids to he exploration of the small. Their effect on the many forms of science, on those which deal with natural processes, the living cell, bacteria, health and disease, on those which deal with human construction, dyes, drugs, alloys, textiles and the materials handled every day, on those sciences which are concerned with the production, preservation, and the use of food, will be explained by men who have themselves taken part in the conquest of this sub-visible universe.

Hill Sheep Farming

THE Agricultural Improvement Council for England and Wales has set up a Committee "to investigate the present position of hill and upland sheep farming in England and Wales and in the light of modern scientific knowledge to suggest measures that might be taken to improve the condition of hill and upland grazings, the health and hardiness of sheep stocks and systems of stocking and management". The Committee is constituted as follows: Lord De La Warr (chairman); Mr. J. C. F. Fryer, Mr. Moses Griffith, grassland adviser at the Plant-breeding Station, Aberystwyth; Mr. David Lewis; Dr. R. F. Montgomerie; Prof. G. W. Robinson, professor of agricultural chemistry in the University College of North Wales, Bangor; Dr. R. W. Wheldon, lecturer in agriculture at King's College, Newcastle-upon-Tyne; Mr. W. Wilson. Mr. D. H. Dinsdale, adviser in agricultural economics, King's College, Newcastle-on-Tyne, will act as technical secretary to the Committee, and the administrative secretary will be Mr. J. H. Banbury, of the Ministry of Agriculture and Fisheries, Lindum Hotel, St. Annes-on-Sea, Lancs.

Announcements

SIR JOHN RUSSELL, director of the Rothamsted Experimental Station, has been appointed adviser to the Soviet Relations Branch of the Ministry of Information. During his well-known researches in agricultural science, Sir John has come into close contact with Soviet men of science and has travelled widely in the U.S.S.R.

MR. J. K. ROSS has been appointed assistant conservator of forests, Sierra Leone, in the Colonial Service.

PROF. ERWIN PAYR, emeritus professor of surgery at Leipzig University, has been awarded the Goethe Medal for art and science.

To meet urgent needs, some of them arising from the War, four new teaching departments have been set up at Leeds General Infirmary, devoted respectively to thoracic surgery, physiotherapy, radiography and radiotherapy, and dietetics.

THE Board of Education announces that the scheme of State bursaries in science, tenable at universities and certain technical colleges, carrying fees and maintenance allowances, which was instituted last year to meet the demand for technical officers for the Armed Forces and for war industry, is being continued in 1942. Bursaries will be awarded as last year in engineering, physics-with-radio, and chemistry. Full particulars are being sent to the headmasters and headmistresses of secondary and public schools.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Excitation of Nematocysts

THERE has in the past been considerable discussion concerning the nature of the stimulus which causes the nematocysts of Cœlenterates to discharge. In some cases, it is quite clear that the mechanical stimulus to the cnidoblast causes an explosion of the enclosed nematocyst. But for the majority of nematocysts, discharge only takes place in the presence of food, and it has been suggested that the stimulus is essentially a chemical one. During a long series of experiments on the feeding of *Anemonia sulcata*, interesting evidence has been obtained as to the mode of excitation of nematocysts. In agreement with Parker and Van Alstyne[1], I find the cnidoblasts of the tentacles of Anemonia are independent effectors. They respond, however, selectively to food. If touched by a clean glass rod, no discharge is normally obtained. If touched with a piece of human skin, there is copious discharge. The discharge, however, only takes place where there has been mechanical contact. Strong food solutions sometimes seem to cause spontaneous discharge of a few nematocysts. But it is easy to show that this is of no direct significance in the normal reaction. As a direct chemical stimulus, food is far less effective than certain surface-active substances such as bile salts (0·1 per cent), which produce a complete spontaneous discharge of the nematocysts. This action is, however, quite different from the normal response. Cotton wool soaked in dilute bile salts does not adhere to the tentacles ; the nematocysts being discharged by the diffusing bile salt before contact is made. On the other hand, cotton wool soaked in food solution causes extensive discharge of nematocysts into the mass on contact. This is true even though the food solution employed is far below the concentration for spontaneous discharge. Clean cotton wool, soaked in sea water as a control, produces no discharge.

A simple experiment helps to explain these curious facts. If a tentacle is touched by a small clean glass bead, no nematocyst discharge takes place. If the tentacle is now immersed in food solution, for example, 10 per cent human saliva in sea water (centrifuged), there is little or no evidence of spontaneous discharge. But if the tentacle is now touched with a clean glass bead, a profuse discharge of nematocysts takes place on to the bead. Clearly, the food solution has acted by lowering the threshold to mechanical stimulation. We have in the cnidoblast the remarkable system of an independent effector excitable by a mechanical stimulus, but only excitable in this way when under the influence of specific chemical substances in the food.

Analysis of active food material shows that the effect is not given by carbohydrates or carefully fat-freed proteins or their derivatives. The active substance is normally strongly adsorbed on protein, whence, however, it can be extracted by alcohol or acetone, though not by ether. The obvious suggestion is that the active substance is a lipoid possessing polar groups. This suggestion is borne out by the fact that glass beads coated with trimyristin produce a discharge on coming into contact with the cnidoblasts. The results of this work will be published in a forthcoming paper.

Dr. J. H. Schulman of the Department of Colloid Science, Cambridge, and I have investigated the effect of a number of surface-active substances, both with respect to spontaneous discharge and to the normal contact response. The effects are highly selective. Whereas the salts of bile acids produce nematocyst discharge at low concentrations, many other capillary-active compounds such as the sulphate, amine or carboxylic salts of long-chain aliphatic substances cause no obvious spontaneous discharge, even in concentrations sufficient to cause rapid cytolysis.

Of the substances tested, the contact response was greatest to aliphatic esters such as trimyristin and ethyl stearate. Even pure paraffin wax can produce a moderate contact discharge of the cnidæ. On the other hand, long-chain fatty acids in which the surface is hydrophilic, or paraffin rendered hydrophilic by the presence of fatty acids or protein is without effect. This strongly suggests that the lipoid substance concerned must come in actual contact with the lipoid surface layer of the cnidoblast in order to exert its effect. These results will be published in another paper.

Department of Zoology,
Cambridge.
Jan. 6.

C. F. A. PANTIN.

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[1] *J. Exp. Zool.*, 63, 329 (1932).

Properties of Cuticle and Insect Ecology

THERE is no doubt that the physiological significance of insect coloration has not yet been fully realized by ecologists, while its direct survival value has often been overstressed. From this point of view Dr. Kalmus's article in NATURE[1] is to be welcomed. His treatment of the problem, however, is such that it may bring undeserved discredit to essentially sound ideas. Starting with references to some recent investigations on the physical properties of insect cuticle, Dr. Kalmus proceeds to formulate thirteen "Rules", based on the still scanty results of those investigations, on a number of assumptions (for example, "a dark cuticle is mechanically the stronger", which he admits to be an assumption not yet proved, but on which no less than four "Rules" are based), and on teleological speculation. The evidence quoted in support of each "Rule" is exceedingly meagre and often inaccurate, as a few examples will show. The mole cricket quoted in Rule 3 is not "entirely dark" but paler than most of its relatives. Rule 4 ("giant forms are usually black ; bright colours are more frequent among small insects") is not supported by any evidence, and its correctness is highly doubtful. Mayflies, on the sole support of which Rule 9 rests, are not necessarily pale and some are even black. Eggs of Phasmodea (Rule 10) are not "dark and hard", but always hard and only sometimes dark. Rule 11, stating that "most non-black insects are found in the tropics" has since been presented[2] in a more intelligible way by saying that "the proportion of non-black insects is greater in the tropics", but it is legitimate to ask on what evidence this statement, implying the existence of some numerical data, is based. Similar statements of alleged quantitative character constitute many of the "Rules", and it is surprising that they should emanate from a University Department of Biometry where more respect for statistical data would be expected.

The lack, or inadequacy, of evidence in support of the "Rules" caused me (in a letter to Dr. Kalmus) to call them dogmatic, and Dr. Kalmus is merely using a polemical trick in contrasting this definition[2] with that of Prof. Hale Carpenter[3], who criticizes them for being vague. The fact is that most of the "Rules" are dogmatic, though the wording of some of them is vague. This vagueness ("usually", "frequently") anticipates all criticism based on concrete examples; a further safeguard is provided by explaining that the effects of the thirteen "Rules" are often contradictory and final results difficult to foretell; still further, all cases of coloration dependent on subcuticular pigmentation are brushed aside as irrelevant, although, for example, the absorption of heat radiation by a black insect does not depend on the histological location of the black pigment. In fact, Dr. Kalmus's attitude seems to be this: dark (or light) colour of any insect species must have *some* teleological reason, and if the colour contradicts one "Rule", another can be applied, until an "explanation" of the colour is found. As there are thirteen "Rules", the choice is wide. The technique of applying the "Rules" has been excellently demonstrated by Dr. Kalmus himself, in reply to Prof. Hale Carpenter's[3] query as to why in Ngamiland the diurnal Tenebrionids and the nocturnal Carabids are both black. The answer is "I think the beetles of Ngamiland provide quite good examples of Rules 12 and 14 (drought and vagility)". What kind of ecologist would be satisfied with this light-hearted way of solving his problems? Another example of Dr. Kalmus's versatility concerns weevils, the integuments of which are usually very hard, whatever the colour (thus refusing to observe "Rule" 3); in this case "a different process of hardening seems to be at work".

It is really incomprehensible why Dr. Kalmus formulated his points as "Rules". If he had said, for example, that long-lived insects *may be expected to be* darker than their short-lived relatives, it would have been a reasonable deduction from properties of cuticle; but saying, as he does, that "long-lived insects *are* darker, etc." amounts to a dogmatic statement, which is possibly untrue. Most of the thirteen points deserve the attention of ecologists, since they suggest problems concerning physiological causes and biological effects of coloration; but it is to be sincerely hoped that no ecologist will be tempted to explain away his problems by consulting Dr. Kalmus's list of rules, or to follow his example of solving them with the aid of meagre physiological data, supplemented by wishful thinking on teleological lines.

B. P. Uvarov.

Imperial Institute of Entomology,
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S.W.7. Dec. 19.

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[1] Nature, 148, 428 (1941).

[2] Nature, 148, 694 (1941).

[3] Nature, 148, 693 (1941).

In my article I proposed a system of deductions from newly discovered physical properties of cuticle, formulated them as ecological rules and illustrated them by some examples. As the working mechanism of adaptation I postulated natural selection, thus escaping, as I hoped, the accusation of teleology.

If, as Dr. Uvarov recommends, ecologists interest themselves in these deductions, their observations will show, in due course, how many of my ideas are sound.

H. Kalmus.

Difference in Resistance to Toxic Substances of Mutants of Drosophila of Different Body Colour

In previous papers[1,2] it has been shown that mutants of four species of Drosophila with light-coloured cuticles are less resistant to desiccation than are those of darker body colour. This was taken to indicate that the light cuticles are more permeable to water than the dark. The following differences in resistance of the light and dark insects to various toxic substances may also be explained by differences in the permeability of the cuticles.

Heavy and light petroleum oils, a tar-oil emulsion in water, a pyrethrum extract and weak solutions of sulphuric acid were sprayed on batches of flies taken from a segregating F_2 generation by means of an apparatus[3] designed to give uniform replicable deposits of known amounts of contact insecticides. The flies were supported on a textile material (tricoline) and males and females of the mutant and wild type flies were treated at a time, the insects being previously narcotized with carbon dioxide.

The *yellow* mutant of *D. pseudo-obscura*, race *A* and *D. melanogaster* showed a significantly lower resistance to all the substances tested as measured by the number of survivors, when compared with the wild type. The mutant *black* in *D. melanogaster* showed a slight increase in survival, whereas there appeared no difference between the mutant *ebony* in the same species and the wild type.

The yellow mutant of *D. pseudo-obscura* lost more weight after spraying with heavy or light oil than the wild type. The loss in weight of both forms was greater after treatment with the more volatile oil.

A collapse of the eyes of the dead flies was noticed after treatment with the light oil. The frequency of this effect was significantly greater in the yellow mutant of *D. pseudo-obscura* than in the wild type. This effect was not observed with the other substances.

It is not clear at present whether the differences in reaction of the mutants to all the chemicals used are due to a common cause. With the exception of pyrethrum, the substances tested or related products are likely to be found in the atmosphere, precipitations and on the vegetation of industrial districts. The differential behaviour between the light and dark insects found in these experiments may thus provide an explanation for the progressive selection of melanic forms in these areas.

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[1] Kalmus, H., Nature, 147, 455 and 148, 428 (1941).

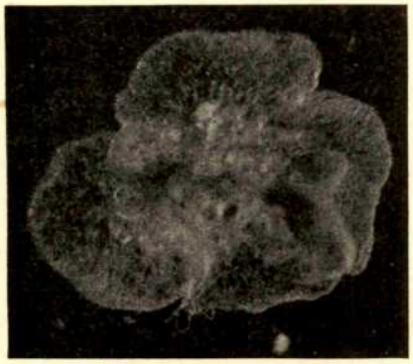
[2] Kalmus, H., *Proc. Roy. Soc.*, B, 130, 185 (1941).

[3] Potter, C., *Ann. Appl. Biol.*, 28, 142 (1941).

A Ctenophore from the Palestinian Coast

Some six weeks ago I set up a series of small sea-water tanks. One of these was planted with *Caulerpa prolifera*, *Caulerpa crassifolia* and Zostera sp. On October 29 we noticed in this tank three specimens of a creeping Ctenophore.

All the material present was from the Palestinian coast, near Jaffa. So far as known to us, no Platyctenean has up to now been described from the Mediterranean. Therefore we presume that we are dealing with the Red Sea form (*Cœloplana Metschnikowii* Kowalewsky, 1880) or else with a new species. If our specimens should belong to the Red Sea species, this would mean that this interesting animal—like many others—has succeeded in penetrating through the Suez Canal into the eastern Mediterranean.



A preliminary examination tends to confirm this diagnosis of the genus Cœloplana: the animal appears to be devoid of comb-plates but possesses the characteristic aboral papillæ of Cœloplana. The animals are 12–13 mm. long and 9 mm. broad, and they were observed both creeping on the substrate and hanging on the water surface. One specimen swallowed an Isopod of 2 mm. length. The tentacles can be extended more than 15 cm. The accompanying photograph, taken by Dr. W. Koch, shows a specimen with one tentacle partly extended.

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Nov. 12.

J. Haas.

Northern Fringe of the Palæolithic in England

The question as to whether the northern fringe of the Palæolithic in England extended into Yorkshire or not has long been a matter of controversy. Certain archæologists have supported such an extension on the ground that many palæolithic types of implement have been discovered there, while most geologists have denied it on the ground that climatic conditions would have rendered any human penetration of Yorkshire impossible throughout the Ice Age.

For a thesis recently accepted by the University of Durham I have made a close investigation of this problem, re-examining both the implements discovered and the details of their discovery.

The investigation has revealed that many of the implements are undoubted palæoliths, but do not belong to any of the earlier Palæolithic cultures, being, with the possible exception of one group from Nidderdale, Debased Creswellian. At two sites at least, one in the Huddersfield region and the other near Settle, these palæoliths were certainly deposited prior to the earliest appearance of Mesolithic influences. The strata in which these palæoliths occur, in all cases where they can be identified, are post-glacial in date. The Palæolithic sites, almost without exception, are situated on elevated ground, the majority on the Pennine Ridge, a few on the Yorkshire Moors and Yorkshire Wolds. The genuine palæoliths are few in number compared with the implements of later cultures; a few of the stone implements are of flint and comparatively well made, but the majority are of chert and exceedingly crude. As a general rule the better-made implements are the earlier, the more crude the later, though the latter tend to improve slightly as the period draws to a close.

These facts make it clear that there was a Palæolithic period in Yorkshire, but that this period was post-glacial, not interglacial, in date. Thus the opposed views of the geologists and the archæologists can be largely reconciled.

It is possible to reconstruct in broad outline the sequence of events which brought about the above-mentioned conditions. The Creswellian Culture is known to have persisted in Derbyshire and Lincolnshire long after the contemporary palæolithic cultures on the Continent and even in southern England had been superseded by the Mesolithic[1]. During this period the ice withdrew from the greater part of Yorkshire, and immediately small hunting parties began to enter that county, keeping to the elevated ground, as the valleys and plains would still be impassable.

At first these parties would be mere seasonal visitors, returning to the Derbyshire and Lincolnshire centres for the winter; but as conditions improved, some at least settled in Yorkshire, living the life of nomadic hunters. The original migrants would take with them flint tools and weapons manufactured by skilled workmen at the North Midland sites, thus accounting for the comparatively well-made implements; but their descendants would have to improvise with the somewhat intractable local chert, which explains the deterioration of the workmanship.

There appears to have been a break in these migrations, during which mesolithic influences reached the Derbyshire and Lincolnshire sites, and when conditions further improved and a general advance northward was made, it was by a people in a mesolithic stage. The descendants of the earlier migrants were then either absorbed or became extinct.

It is hoped at some future date to publish full details of the evidence on which these conclusions are based, as well as a discussion of several subsidiary questions arising out of the main problem.

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Frizinghall,
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Dec. 27.

H. N. Gibson.

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[1] Clark, J. G. D., "The Mesolithic Settlement of Northern Europe" 220 (Cambridge, 1936).

Names of Electrical Units

If the E.S.U. system is to be retained, Dr. E. A. Guggenheim's suggestion[1] that the unit of electrical charge in this system should be called the "franklin" has much to commend it. But why retain the E.S.U. system? The object of the M.K.S. system is to replace three existing ones, with their cumbersome conversion factors, by one single system which meets all practical requirements.

It is unsound to give an arbitrary unit value to more physical quantities than necessary, though the practice is sometimes unavoidable (we can, for example, scarcely hope to avoid using the horse-power as well as the watt), but in electrical work there is no need to give an arbitrary value to more than one quantity in addition to the three mechanical ones of length, mass and time. In the M.K.S. system the quantity selected for permeability is 10^7 that of a vacuum. This automatically causes the permittivity of a vacuum to be $1{\cdot}113 \times 10^{-10}$ units. Arbitrarily to make the permittivity of a vacuum one unit as is done in the E.S.U. system is to over-determine the units. It is very much to be hoped that this practice will be dropped, particularly as the exact conversion factor is not such a round figure as given in Dr. Guggenheim's table. It would only be so if the velocity of light were exactly 300,000 km. per second, which it is not.

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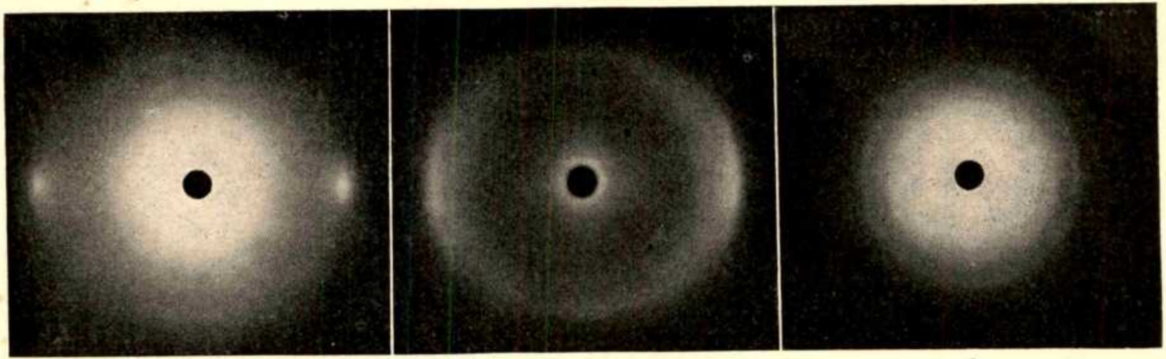
[1] NATURE, 148, 751 (1941).

Crystallization in an Inflated Rubber Balloon

IT is well known that an oriented crystallization is produced in rubber by stretching. The rubber can be made to crystallize also by a two-dimensional homogeneous dilatation, as in the skin of an inflated rubber balloon. I have experimented with small balloons of about 1 cm. diameter when slack, made of pure vulcanized latex by dipping. When a balloon like this is inflated to 3–4 cm. diameter and an X-ray beam strikes the sphere tangentially, photographs result as shown in Figs. 1 and 2, taken with balloons approximately 0·1 and 0·6 mm. thick when slack. The spacings given by the reflexions in the horizontal plane, which contains the centre of the sphere, is 4·22 A.; those of the short arcs at top and bottom are 4·95 A. and 6·24 A., corresponding to the (200), (012) and (002) reflexions in the ordinary fibre diagram which was taken separately. The arcs are blurred as they originate on an extended area of the sphere. The sharpness of the horizontal reflexions, on the other hand, is enhanced by a focusing effect.



1
Thickness, 0·1 mm., inflated to 31 mm. diameter. Distance, 8 cm., beam tangential.

2
Thickness 0·6 mm., inflated to 49 mm. diameter. Distance 8 cm., beam tangential.

3
Same as 2. Distance 6·5 cm., beam through centre.

X-RAY DIAGRAMS, TAKEN WITH UNFILTERED COPPER RADIATION, OF INFLATED RUBBER BALLOONS.

Accepting a monoclinic structure with an angle $\beta = 83° 20'$ as proposed by Lotmar and Meyer[1], the dimensions of the elementary cell work out as $a = 8{\cdot}5$ A., $b = 8{\cdot}2$ A. and $c = 12{\cdot}6$ A. for this particular specimen; b is the fibre axis indicating the direction of the main valency chain.

With this assumption, we interpret the result represented by Figs. 1 and 2 as follows. The dilatation of the rubber skin produces an oriented crystallization, the orientation being brought about by a tendency of the crystallites to arrange themselves with the b-c-plane in the plane of the skin, that is, with the shorter a-axis perpendicular to the skin. The distribution in the plane around the normal is at random, giving as reflexions parts of Debye rings.

The effect is less marked in the thicker specimen, as will be seen when comparing Figs. 1 and 2. Fig. 3 is a photograph taken with the X-ray beam passing through the centre of the sphere. This gives, of course, two sets of reflexions, from the near and the far side of the balloon respectively. The second one is scarcely visible in the reproduction. There are two Debye rings each with spacings equal to the (002) and (012) reflexions of which the latter is much stronger. The (200) reflexion is either completely absent or extremely weak. These findings appear to corroborate the proposition outlined above, which indeed is closely connected with what is known as 'higher orientation' in thin stretched rubber bands.

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[1] Lotmar and Meyer, *Monatshefte*, 69, 115 (1936).

A Reversible Discharge Tube

IN a recent letter, Asundi, Singh and Singh[1] have described effects observed with a so-called reversible discharge tube. The phenomena recorded appear to be most easily explained by assuming that the discharge tube leaked slightly. This would account for the appearance of the hydrogen spectrum when the tube was freshly swept out with hydrogen, the appearance of nitrogen bands after standing, and the reappearance of the hydrogen spectrum on continuous running, the nitrogen being cleaned up by the aluminium electrodes, a well-known effect which is commonly made use of in hydrogen discharge tubes. The cleaning up would not occur so readily with external electrodes, and hence the discharge tube would be expected to continue to show nitrogen bands.

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[1] NATURE, 149, 22 (1942).

RESEARCH ITEMS

The Veddahs of Ceylon

An important addition to our knowledge of the Veddahs of Ceylon has been made by W. C. Osman Hill, professor of anatomy, Medical College, Colombo (*Ceylon J. Sci.*, Sect. G, Anthropology, 3, 27; 1941). He has taken an extensive series of measurements of 34 living males of the race, noting in particular colour and hair development; 16 members of the series measured came from one group or clan—the Danigala. He adds measurements and descriptions of 68 skulls and 28 skeletons—most of which are in European museums, but others have been obtained from original sources. Particularly valuable are the photographs of living natives, among which one recognizes not only the more common Veddah type but also others showing resemblances to the Australian aborigine and to negroid peoples. These aberrant types also appear among the Dravidian-speaking tribes of Southern India. Dr. Osman Hill finds the outstanding characteristics of Veddahs—as of all dwarf races—to be an arrest of development at an infantile or immature stage; hence the small stature of the Veddah (the average male measures only 5 ft. in height), the tendency to the suppression of hair on face and body, the short, wide face, and in particular the small head and brain. In their physical appearance, the Veddahs are quite unlike the Bushmen of South Africa, and yet Prof. Osman Hill finds the two races have many cranial characters in common, most of these being of an infantile nature. The last racial census of Ceylon (1921) gave the Veddah population as 4,510; the numbers are decreasing rapidly; Sinhalese on one side, Tamils on the other, are filtering into Veddah country, with the result that hybridity is becoming common. Indeed, Prof. Osman Hill finds it necessary, on this account, to reject many skulls which have hitherto been accepted as pure Veddah.

Rays and their Allies from the Eastern Pacific

A most useful account by William Beebe and John Tee Van of the rays, mantas and chimæras collected by the Eastern Pacific Expeditions of the New York Zoological Society has been published (Fishes from the Tropical Eastern Pacific. Part 3. Contribution No. 630, Department of Tropical Research, New York Zoological Society, *Zoologica*, Oct. 1941). This paper is concerned with collections from several expeditions and contains keys to the families of rays and mantas of the tropical eastern Pacific and to the genera and species. Forty-three rays and two chimæras are described with figures. Range, colour notes, field characters, size, local distribution, abundance, food and breeding are included in the description of each species whenever possible. The food notes are interesting. It is shown that several rays eat polychæte worms and small shrimps. *Narcine entemedor* had in its stomach "a pure culture of red polychaete worms, armed with strong spicules". *Discopyge ommata* fed on Amphipods, small shrimps and worms. This ray has a very conspicuous pattern and gives fairly strong electric shocks. Several species contained young in various stages of development and in others there were egg cases. A female manta or sea-devil captured at the Galapagos Islands was eighteen feet in width and had an embryo 28 in. across, the disk with its tail protruding from the parent and the yolk sac almost absorbed—almost ready to be born.

Young Pacific Sailfish

William Beebe has described two very young sailfish (*Istiophorus greyi*), one of which is the smallest ever seen (Eastern Pacific Expeditions of the New York Zoological Society. XXVII. Contribution No. 629. Department of Tropical Research. New York Zoological Society. *Zoologica*, 26. Part 3, Nos. 19–27; 1941). These were taken on the Eastern Pacific *Zaca* Expedition (1937–1938), one off the western coast of Mexico, 3¼ in. long, which came up to the submerged light at night over a depth of about 67 fathoms, the other 1,200 miles to the south-east, off Costa Rica, 1⅝ in. long, taken in similar circumstances. The detailed descriptions of these two fishes are of great interest, as are also the notes on colour, habitat and especially the food. Externally they resemble the adult, having already a greatly elongated upper jaw and pelvic fins and enormously expanded dorsal fin. Internally, however, they are very different; their jaws are provided with quite ordinary teeth and the body is covered with scales. The whole skeleton must undergo a complete change and this is probably mainly due to the very different form of feeding and feeding movements. A comparison is made with a young Atlantic sailfish (*Istiophorus americanus*), and it is shown that the food is similar. In each species it was mainly copepods, all small Cyclopoida belonging to the tropical surface forms, and a very young fish, in one case certainly, in the other probably, a clupeoid. The fish were bitten in two and the copepods swallowed whole. The food of an adult *I. greyi*, also from the *Zaca* Expedition and weighing 115 lb., was seven small and one large squid, a two-inch paper nautilus, shell and inmate, and a 40-mm. Chaetodon, all quite uninjured. The fact that all this material is swallowed whole and undamaged is striking, especially as the adult fish is commonly reputed to obtain its food by using its snout like a slashing broadsword.

Memory in Insects

W. H. Thorpe (*Proc. Roy. Soc.*, 127, 424–433; 1941) has shown that larvæ of Nemeritis and *Drosophila melanogaster* reared on particular media gave rise to imagos which preferred these. Thus adults of *D. melanogaster* arising from larvæ reared on media containing essence of peppermint were not repelled by the smell, as are normal cultures. J. E. Cushing (*Proc. Nat. Acad. Sci.*, 27, 496–499; 1941) has been experimenting with a pure strain of *D. guttifera* which normally inhabits fungus-infested food. He raised some larvæ on fungus-free and some on fungus-infested media, and allowed the resulting adults to choose between them for egg laying. Again the conditioning of the larvæ significantly influenced the preference of the adult. He points out that this physiological change in the life of Drosophila acts on the mechanism of populations by influencing isolation, population size and selection pressure in a somewhat similar manner to the homing of birds or of salmon or to mating preferences.

Size Inheritance in Tomatoes

J. W. MacArthur (*J. Hered.*, 32, 291–295; 1941) has used four lines of tomatoes which have been inbred for at least twelve generations to explore the manner of inheritance and effect of size genes in the tomato. By intercrossing these lines, and planting lines and hybrids in a Latin square, an analysis of the fruit weights can be made by separation of the variance due to environment (0·4 per cent), to varieties (99·4 per cent) and to error (0·2 per cent). Further, it was found that the F_1 generation closely approaches the geometric mean of the parental lines. Thus it is demonstrated that the substitution of one set of genes for another gives a geometric and not an additive effect.

Photo-decomposition of Acetone

THE photo-decomposition of gaseous acetone is apparently a complex process, ethane, carbon monoxide and diacetyl being formed at room temperature in varying ratios depending on the circumstances. A re-investigation of the process by R. Spence and W. Wild (*J. Chem. Soc.*, 590 ; 1941) has brought to light some new features. It is shown that the apparently contradictory results found in earlier research by the authors and by Herr and Noyes in the continuum region of absorption can be represented by a single expression derived from a common mechanism. A purely radical type of mechanism is shown to be excluded by results in the banded region of absorption. The effect of pressure on the quantum yield and on the ethane/CO ratio is explained by the assumption of two activated states of the acetone molecule with very different life-periods of the order of 10^{-8} sec. and 10^{-2} sec., the second being a metastable state. This mechanism is :

$$(CH_3)_2CO + h\nu = (CH_3)_2CO'$$

$$(CH_3)_2CO' \xrightarrow{10^{-8}\text{ sec.}} CH_3 + CH_3.CO$$

$$(CH_3)_2CO' + M = (CH_3)_2CO'' + M$$

$$(CH_3)_2CO'' \xrightarrow{10^{-2}\text{ sec.}} C_2H_6 + CO$$

$$(CH_3)_2CO'' = (CH_3)_2CO$$

$$(CH_3)_2CO'' \xrightarrow{\text{wall}} C_2H_6 + CO.$$

At low pressures decomposition into radicals predominates and C_2H_6/CO can reach high values, while at pressures above 100 mm. direct decomposition into ethane and carbon monoxide is the primary process. The theory is complicated. but each phase has been related to some definite experimental result. It should be noted that the excited molecule of longer life does not yield free radicals but either reverts to the normal state or decomposes into ethane and carbon monoxide.

Intuition and Higher Space

THE term 'geometry' is now used in a very wide sense, and some mathematicians feel that there is an essential difference between that of one, two or three dimensions, in which spacial intuition is of great value, and modern extensions to four, five, or even an infinite number of dimensions. A method for the graphical representation of these higher kinds of spaces has now been given by M. Randall and B. Longtin (*J. Washington Acad. Sci.*, 31, 421 ; 1941). For n dimensions we replace the desirable but unattainable n mutually perpendicular axes by n parallel lines on a sheet of paper, so that a point in space of n dimensions is represented by n points on the paper. It is easy to pass to functional space of an infinite number of dimensions, for the point in functional space is represented by a continuous curve. Two applications of the methods of this paper are of some importance. They can be applied to the study of processes for separating the components of a mixture of several chemical compounds, and to the determination of the intensity of luminous energy concentrated in each wave-length of a spectrum.

Origin of Planets and Satellites

IN a paper on this subject (*Mon. Not. Roy. Astro. Soc.*, 101, 7 ; 1941), R. A. Lyttleton introduces certain modifications in the results that he had previously obtained. In some of his earlier papers he showed that in the evolution of a primitive rotating planet, when a state of instability was reached, the division produced a pair of masses of mass-ratio 3 : 1 approximately. In dealing with the gravitational energy of the critical ellipsoid, Lyttleton used a numerically incorrect value which led to the above ratio, but the use of the correct value shows that the mass-ratio must be at least 6 : 1 and possibly higher. In these circumstances it does not seem possible that Jupiter and Saturn should have originated from a single mass, as previously suggested, unless the initial mass-ratio has been reduced as a result of some increase of mass by these planets since this stage of their formation. Various lines of evidence suggest that such an increase could occur, though there is nothing to show that any of these alleged factors were actually effective. The modification introduced does not necessarily exclude the method of formation of the terrestrial planets and of the satellite systems of the great planets, which Lyttleton had suggested in his earlier papers, but it opens up the possibility of other ways in which various pairs of planets may be related. Of these the simplest situation would be obtained on the supposition that two primitive planets evolved by fission to produce Jupiter and Neptune, say, from one of them, and Saturn and Uranus from the other. It is admitted, however, that all four planets may have had separate origins, and other possibilities exist between these two cases.

Spectrophotometry of the Night Sky

THE intrinsic brightness of the night sky sets a natural limit to the photography of distant nebulæ with large modern reflecting telescopes. If the spectral distribution of the radiation from the nebulæ approximates at all closely to that of the light from the sky, we can expect no improvement of this position by the use of such devices as colour filters. However, the light from the nebulæ is made up largely of starlight little different in quality from sunlight, whereas most of the night sky radiation is terrestrial in origin and is similar to auroral light ; there may thus be a difference in spectral distribution which could be exploited in astronomical photography. H. W. Babcock and J. J. Johnson have now compared the energy distribution in the light of the night sky with that in the Andromeda nebula (*Astrophys. J.*, 94, 271 ; 1941). Spectra of both sources were obtained on Mt. Palomar with a quartz spectrograph fitted with an *f*/1 Schmidt camera and attached to a 12-in. reflecting telescope. Each spectrogram was separately standardized with a standard lamp operated at 2580° K. The spectral energy curves are roughly parallel from the red down to about 4500 A. From there to about 3200 A., however, the night-sky intensity remains constant while the nebular intensity drops sharply. It is therefore suggested that improved contrast in the direct photography of nebulæ can be obtained by using a filter to remove the unwanted ultra-violet light. This procedure is especially necessary when the elevation of the telescope is small, since the nebulæ are then reddened by atmospheric absorption, while the night sky is brightest at low altitudes.

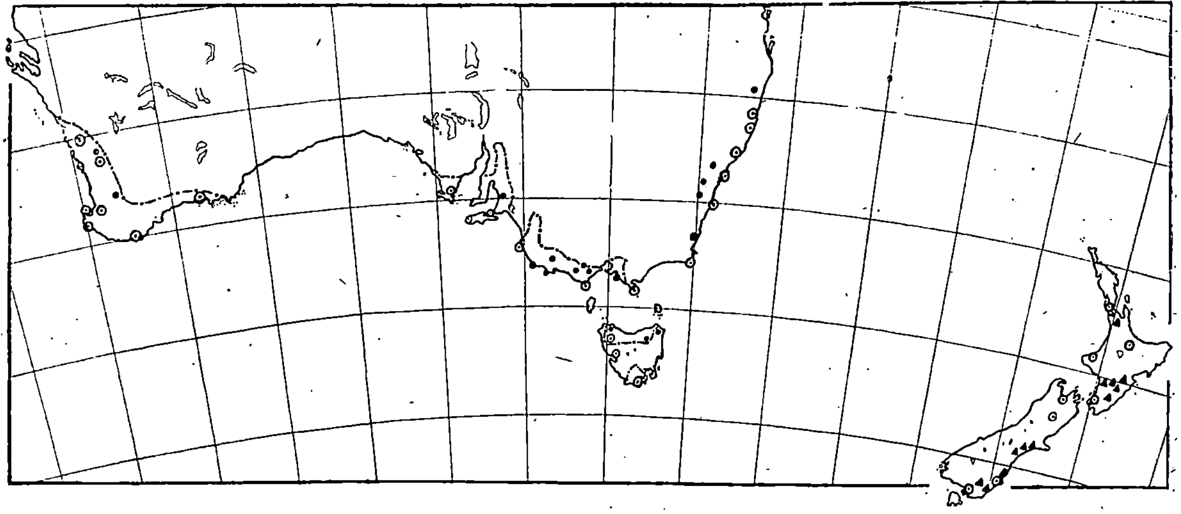
THE PREDICTIVE METHOD IN ANIMAL ECOLOGY

By DR. D. STEWART MACLAGAN

Department of Zoology, University of Durham

EVERY scientific problem resolves itself into a quest for the relationship between two or more variables. The discovery of these inter-relations provides the basis for prediction and control, so important in the applied aspects of a science, and bespeaks the entry of the latter into the highest phases of its development. Although biology is one of the younger sciences, it has made such great advances in the descriptive phases that further developments are taking place along quantitative lines, with the ultimate objective of *predicting* the organic response to given conditions. The methods elaborated by the animal ecologist for the forecasting of biological events in time, or in space, are still comparatively rough hewn, and certain fundamental principles will have to be taken as proved, for the present, since lack of space prohibits presentation of the ever-increasing mass of evidence upon which they are based.

The first is that populations of animals are controlled by a complex of environmental factors which are continually varying in intensity, both spacially and chronologically; and of which the climatic factors play the dominant part in the initiation (but not always in the termination) of the condition known as an epidemic or 'plague.' The second is that, although numerous factors operate simultaneously to retard population-increase in Nature, there are great differences in the relative significance of the various phases of the life-cyle, in so far as numerical increase of a species is concerned, so that 'critical' periods can be recognized. Thirdly, the critical periods are usually associated with the early stages of existence or with reproduction. The primary task of the biological forecaster, therefore, is the discovery and climatological delineation of critical periods in the life-cycle, such periods resulting from the high susceptibility of certain stages or processes to deviations from a narrow optimal range. These ecological concepts synthesize my views as the result of investigations conducted over a period of twelve years, and it is of interest to find that the predictions which were ventured in some of the earlier researches have been vindicated by recent experience, as follows:



From 1928 until 1930, a detailed ecological study of the collembolan, *Smynthurus viridis* L., was undertaken, at the Parasite Laboratory of the Imperial Institute of Entomology.[1] Utilizing field data in combination with the results of planned laboratory experimentation upon the 'field physiology' of the insect, an attempt was made to determine: (1) the complete geographical range of existence of the insect, (2) where it would cause damage of economic significance every year, and (3) where it would become of economic importance occasionally. On analysing the environmental controlling complex of Smynthurus, it was ascertained that the minimum rainfall for existence of this species is the minimum rainfall for oviposition, namely 0·12 in. a month, because the moisture requirements of this process are higher than those of any other process or phase in the life-cycle. The upper rainfall limit is approximately 7·0 in., due to fungus and bacterial attacks on the eggs, under conditions of excessive moisture. The upper temperature limit for the species is the maximum which can be tolerated by the stage least tolerant of high temperatures, namely, the embryonic nymphs, which cannot survive mean temperatures exceeding 66°F. The other temperature extreme is determined by the stage the activity of which ceases first when the temperature falls, and this is the egg, its threshold of development being approx. 44°F. Optimum conditions for multiplication of Smynthurus occur when there is a monthly rainfall of 3·1–6·0 in., together with a mean monthly temperature of 52°–57°F. The damage to lucerne and clovers becomes of economic significance when these conditions obtain for two consecutive months. Further, the areas in which the insect becomes of economic significance occasionally are characterized, in general, by a monthly rainfall of not less than 2·5 in. combined with a mean monthly temperature of 51°–58°F., exclusive of the areas which conform to the requirements of the optimum environment.

Based upon the above criteria of favourability, a map was prepared to illustrate the predicted geographical *range* of Smynthurus and the areas of probable *economic* significance. As a result, it was stated (*loc. cit.*, p. 181)—"it is evident that there are several

DISTRICTS COLONIZABLE BY *Smynthurus viridis* L., (1) FAVOURABLE, (2) HIGHLY FAVOURABLE.

New Zealand	Many stations	Auckland, New Plymouth, Wellington, Dunedin, Invercargill, Rotorua, Nelson, Hanmer, Gore
W. Australia	Guildford, Perth, Northam, Narrogin	Watheroo, Albany, Bridgetown, Bunbury, Cape Leeuwin, Cape Naturaliste, Collie, Esperance, Karridale, York
S. Australia	Adelaide, Cape Northumberland	Port Lincoln, Cape Borda, Kingscote, Robe
Victoria	Cowes, Colac, Hamilton, Portland, Terang	Gabo Island, Wilson's Promontory, Lorne, Cape Otway
N.S. Wales	Lismore, Maitland West, Bowral, Parramatta, Adelong	Kempsey West, Port Macquarie, Sydney, Jervis Bay Nowra, Moruya Heads
Tasmania	Stanley, Eddystone Point, Zeehan, Launceston	Hythe, Cape Sorell, Waratah, Currie
	(1)	(2)

countries to which Smynthurus is potentially a serious economic menace, the most important being New Zealand, the south-west corner of Cape Province, Natal, Chile, New South Wales, and the United States of America". At the same time, an attempt was made to portray, in greater detail, the limits of existence and of economic significance of the insect in Australia, on account of its known depredations in Western and South Australia. This led to the conclusion (*loc. cit.*, p. 183), "that there is a large tract of country in New South Wales and southern Victoria from which the insect has not yet been recorded, but to which, in the event of its introduction, it would undoubtedly prove to be a serious economic problem. Also, there exists a fairly large band of territory in the north and western parts of Tasmania which is highly favourable . . . although the insect . . . has not yet had time to demonstrate its full potentialities as regards numerical increase". In view of recent reports upon the economic status of Smynthurus, these statements are of considerable interest to biologists in general and to ecologists in particular.

Thus, commenting on the lucerne flea in Tasmania, Evans[2] says: "it was introduced about 14 years ago and is now responsible for extensive damage to pastures"; whilst Pescott[3], discussing the colonization of Victoria by the species, remarks that this "introduced insect, was, until several years ago, confined to the coastal areas of the Western District of Victoria, but recently it has been found scattered over other portions of the State". Entomologists of the Australian Council for Scientific and Industrial Research[4] report that the pest now occurs "in isolated areas in other districts in this State [Victoria] and in southern New South Wales". The situation in New Zealand has been summarized recently by Dumbleton[5], thus, "In the North Island, the lucerne flea is known to be widely distributed in an area including Bulls, Palmerston North, Dannevirke, Woodville and Eketahuna. There is one isolated occurrence of the flea near Pokeno and another near Maraekakaho. In the South Island, the insect was found to be present over an area including Temuka, Timaru, Waimate, Oamaru, Mosgiel, Balclutha and Gore."

Hence, the predictions ventured by me in 1932 have materialized sooner than I expected. The accompanying map indicates, by means of dotted lines (Australia), and by triangles (New Zealand), the known distribution of the insect in numbers of economic significance; while the climatically favourable and highly favourable areas (based on the original climatic criteria) are represented by means of a dot and a dotted circle, respectively. It is my belief that prediction of the abundance and distribution of animal-populations is a field of scientific endeavour which will yield results of great interest and value. With the co-operation of biologists and meteorologists this branch of ecology should be one of the most powerful weapons in the armoury of the economic biologist.

---

[1] Maclagan, D. S., *Bull. Entom. Res.*, 23, 151 (1932).

[2] Evans, J. W., *Tasman. J. Agric.*, 8, 93 (1937).

[3] Pescott, R. T., *J. Dept. Agric. Vict.*, 35, 371 (1937).

[4] Rep. Coun. Sci. Indus. Res. Australia, 11 (1937).

[5] Dumbleton, L. J., *N.Z. J. Sci. and Tech.*, 20, 197A (1938).

CONDITIONS IN FACTORIES

IN a paper "Factory Inspection: a thirty-five years' Retrospect", given before the Royal Statistical Society on May 20, which has now appeared in the *Journal of the Royal Statistical Society*, Sir Duncan Wilson gives a most interesting picture of the developments under the Factory Acts leading to the prevention of accidents and the elimination of industrial disease, as well as indicating points at which statistical information is still lacking or incomplete. Between 1904 and 1938 the staff of the inspectorate more than doubled. Sir Duncan Wilson paid a warm tribute, which was endorsed in the subsequent discussion, to the way in which from the start the factory inspectors, relying on education and persuasion rather than on the full exercise of their statutory powers, had secured the co-operation of employers and managements. In the same period the expenditure had more than trebled and the figures quoted by Sir Duncan Wilson emphasized the huge increase in the use of mechanical power. While the number of factories has increased by about 70 per cent, the number of workshops or places without mechanical power has been reduced to about one half. The data show that industrial diseases have been fought with much greater success than accidents. Fatal accidents per 100,000 employed decreased from 17·6 in 1904 to 11·2 in 1938 and this decrease may be taken as a measure of the severe accident rate. On the other hand, reported accidents almost doubled in the same period. As the criteria were more stringent in 1904 the difference is much greater than would appear from the actual figures.

Sir Duncan Wilson notes that, although of late the proportion of very large factories has increased, about one third of the working population is accommodated in factories employing not more than a hundred workers and more than one half in factories employing not more than two hundred and fifty workers. The chief work of the factory inspector in fact lies in quite small factory units and the trouble there, as Mr. A. W. Garrett pointed out in the discussion, is that there is often not the broad outlook which characterizes the management in the larger concerns. Sir Duncan also directed attention to the high incidence of accidents among young workers under eighteen.

Statistical treatment of the available data over the period explored indicates a distinct tendency for the numbers employed to rise associated with a smaller tendency for accidents generally to rise and with a tendency for fatal and presumably other severe accidents to fall. The two curves are roughly parallel, variations in numbers employed being positively associated with similar variations not only in the mere numbers of accidents but also with the risk of incurring them. Of the more personal aspects of industry, Sir Duncan does not think that the loss of paternalism involved in modern times in the formation of large combines replacing or absorbing the small employers is a pure loss, but emphasizes that many and probably most of the small employers were first concerned with profit and lastly with the safety, health and general interests of their workers. He refers to the noticeable change in the workers themselves and asserts that the bedraggled, ill-mannered and ill-spoken worker has been replaced by one with self-respect, good appearance and the best manners of any social class. Sir John Forbes Watson, in the discussion which followed, referred to the importance of the analysis of factory conditions in Great Britain as compared with others and the importance of developments in industrial medicine was stressed by Dr. H. B. Morgan, who paid a particularly warm tribute to the work of the factory medical inspectors. Mr. Robert R. Hyde, director of the Industrial Welfare Society, in a written communication, referred to the importance of ways and means of providing the smaller units of industry with some form of the medical service which has already been developed with such success in many large firms.

RECONSTRUCTION AND ECONOMICS

IN a pamphlet entitled "Post-War Poverty and Unemployment Can be Prevented" issued last year (see NATURE, 146, 312; 1940) T. W. Wyatt and D. Caradog Jones challenged the assumption that a period of intense economic depression and serious unemployment is bound to follow the War, and urged that, on the contrary, it should be possible by a carefully thought-out plan, co-ordinating all forms of industrial activity, to change over from war production to peace production, utilizing the vastly improved capacity of production for creating new wealth. A postscript by J. R. Bellerby outlined five stages by which this could be achieved. Messrs. Wyatt and Caradog Jones have now, under the title "Britain's New Order"*, issued as a sequel a further thoughtful study of methods of preventing post-war unemployment, which deals with some of the questions and doubts raised by their earlier pamphlet.

The pamphlet urges that local authorities should be encouraged to prepare schemes of work to put into operation as soon as ever private demand slows down after the burst of activity which may be anticipated immediately after the War. Government departments which are able to do so should set an example by initiating public works when the suitable moment arrives. The appointment of a commission with members drawn from all walks of life and responsible to Parliament is suggested to decide which schemes of public work should have preference and to regulate the purchase of surplus foods and materials for storage in different parts of the country. The criterion for determining the approval of or vetoing of any particular scheme should be its consistency with, or opposition to, the public interest. Every effort should be made to decentralize as much as possible and to interfere as little as possible with private initiative, subject only to the over-riding conditions that the national and municipal interest must come first.

Messrs. Wyatt and Jones urge that modern powers of production are so vast that they must be regulated or they will overwhelm us. It is within our power at the end of the War to build a new world, but we must scrap our old impressions of scarcity and of the need for all-round sacrifice to pay for the War. Taxes, accordingly, they consider should be made as light as possible, and they should be raised or lowered solely for the purpose of regulating purchasing power.

Money or credit required to keep production and exchange functioning should be created directly by the Government up to a strict limit when labour, machinery and materials were all fully and efficiently employed. This demands a high degree of skilled organization for which training and time may be required, and although Messrs. Wyatt and Jones believe that no radical change in the present economic system is required, they point out that sudden transition from a system based on production for profit to a new system based on production for use would be dangerous. The present system can be made to provide a much higher standard of life than we have hitherto enjoyed, and this higher standard will permit us to acquire the better education which is the pre-requisite for the organization of a more rational and efficient system of production for use and service.

All the machinery for a great forward stride, given the right direction and control, is at our command. The large surpluses of all kinds of commodities which are piling up in various parts of the world are as important to the countries of their origin as to those that receive them. Much of the urgent reconstruction required over a wide area will be completed in a relatively short time, and all this work must be undertaken regardless of cost. Purchasing power is the key to distribution, and the solution of the problem of distribution will remove one of the most potent obstacles in the path of a settled peace.

In their attempt to build on past experience, the authors are undoubtedly in keeping with the British tradition, and the work which it is proposed should be entrusted to a Parliamentary Commission is already largely in the hands of the Cabinet Committee under Mr. Arthur Greenwood, the Ministry of Works and Building, or the Leith-Ross Bureau.

Essentially the same ideas are outlined in two articles which have appeared in the October number of the American periodical *Fortune*. In the first of these, Mr. Geoffrey Crowther, editor of the *Economist*, at present visiting the United States, enters a powerful plea for a political democracy which includes a balance, and not merely a mixture, of the social and the profit motives. Mr. Crowther suggests, for example, that the whole of the question of food supply should be removed, in peace as in war, from the operation of the profit motive, and the incentive of order, or purposeful organization by the community, substituted for that of freedom and private profit, in much the same way that education is already organized on a service basis. The concept of social security, however, should not be limited to the satisfaction of basic needs. The extended Bill of Rights must be accompanied by an extended Bill of Duties including specific social service, whether in the defence forces, the health services, or in whatever special sphere the particular citizen may be best qualified to serve.

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* Britain's "New Order": a Plea for a Sane Post-War Employment Policy. By T. W. Wyatt and D. Caradog Jones. Pp. 32. (Birkenhead: John Woolman and Sons, 1941.) 9*d*.

Such service would very materially ease the financial burden of the Citizen's Charter, and Mr. Crowther then suggests that over the remaining half of the national economy where the incentive of profit would continue to function, subject to the watching brief of the Government as trustee for the community, it is important to take the brakes off enterprise, and stimulate economic activity with the view of stimulating employment. The profit motive, he urges, is in dire need of assistance, and like Wyatt and Jones, he attacks the policy of excessive taxation as well as repression of enterprise or individuality through monopolies, cartels, trade associations, or the like. When the basic needs of the citizen have been met and his strongest fears removed, it is in an atmosphere of freedom that the human spirit can develop its full powers, and he contends that it should be possible for both the Left and the Right to accept a balance between freedom and order.

Mr. A. A. Berle, jun., Assistant Secretary of State, in an article on post-war development, urges that every defence industry should have a research staff working on plans for producing peace-time goods. A conference should be held to take inventory of these plans and to lay out a catalogue of the products that will be available when the War ends. This catalogue should be matched against known needs of the country for reconstruction, including such needs as relocation and modernization of city areas, new housing for several millions of families, public works, and nutrition, adequate in kind and quality to ensure public health. These needs are potential markets. Out of these and others like them there should be constructed markets sufficient to ensure full use of our plants and full employment for all our people.

Finance, Mr. Berle argues, is a technical problem, like engineering. We can afford anything for which we have materials, labour and reasonable needs. These are the only stop signs, and common-sense adjustment of war finance to peace finance will permit construction of markets to the extent necessary. Like Messrs. Wyatt and Jones, Mr. Berle is convinced as to the richness of the new era that modern technique puts within our reach, and he concludes with the reminder that economics tends to reflect the desires and wants of a country, and whether our new order is to be an enduring and stable order will depend above all on its moral basis.

FORTHCOMING EVENTS

Saturday, January 24

British Rheologists' Club (in the Department of Physics, The University, Birmingham), at 1.15 p.m.—Discussion on "Classifications of Rheological Properties".

Monday, January 26

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. B. A. Keen, F.R.S.: "Soil Physics, Theory and Practice" (Cantor Lectures, II).

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 3 p.m.—Kodachrome Films by Mrs. Patrick Ness: "Burma, Indo-China, Thailand and Netherlands Indies".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5 p.m.—Discussion on "Is there an Electrical Basis for Water Divining?" (To be opened by Mr. J. F. Shipley).

Wednesday, January 28

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C,2), at 1.45 p.m.—Mr. F. R. Yerbury: "The Post-War Home—Its Interior and Equipment", 4: "Adaptation of Design to Standardisation and Mass Production".

Institute of Physics (London and Home Counties' Branch) (at the Royal Institution, Albemarle Street, London, W.1), at 2 p.m.—Conference on "Electronics" (Chairman: Prof. J. D. Cockcroft, F.R.S.).

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 4.30 p.m.—Annual General Meeting. Sir George Simpson, K.C.B., F.R.S.: "The Electricity of Cloud and Rain" (Presidential Address).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Civil Engineering Assistant experienced in Land Drainage Works—The Clerk to the River Trent Catchment Board, Catchment Board Offices, Derby Road, Nottingham (January 30).

Borough Electrical Engineer—The Town Clerk, Town Hall, Burnley (endorsed 'Borough Electrical Engineer') (January 31).

Lecturer in Electrical Engineering—The Principal, County Technical College, Guildford, Surrey (January 31).

Lecturer in Mechanical Engineering—The Principal, Handsworth Technical College, Golds Hill Road, Handsworth, Birmingham 21.

Lecturer in Electrical Engineering—The Registrar, Wimbledon Technical College, Gladstone Road, London, S.W.19.

Lecturer in Mechanical Engineering Subjects—The Principal, Kingston-upon-Thames Technical College, Kingston-upon-Thames, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Leeds. Report of the Librarian for the Session 1940–41. Pp. 5. (Leeds: The University.) [2412

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 2, No. 11: Quantum Theory of the Chemical Bond. By C. A. Coulson. Pp. 115–139. 2*s*. Vol. 61, Part 2, No. 12: Some Remarks occasioned by the Geometry of the Veronese Surface. By W. L. Edge. Pp. 140–159. 1*s*. 9*d*. (Edinburgh and London: Oliver and Boyd.) [2412

National Central Library. 25th Annual Report of the Executive Committee, 1940–1941. Pp. 16. (London: National Central Library.) [11

Other Countries

Transactions of the San Diego Society of Natural History. Vol. 9, No. 29: The Long-Nosed Snakes of the Genus Rhinocheilus. By Laurence M. Klauber. Pp. 289–332+plates 12–13. Vol. 9, No. 30: A New Species of Rattlesnake from Venezuela. By Laurence M. Klauber. Pp. 333–336. (San Diego, Calif.: San Diego Society of Natural History.) [2412

Bulletins of the Zoological Society of San Diego. No. 17: Four Papers on the Applications of Statistical Methods to Herpetological Problems. 1: The Frequency Distributions of certain Herpetological Variables; 2: Illustrations of the Relationship between Populations and Samples; 3: The Correlation between Scalation and Life Zones in San Diego County Snakes; 4: The Rattlesnakes Listed by Linnaeus in 1758. By L. M. Klauber. Pp. 96. (San Diego, Calif.: Zoological Society of San Diego.) [2412

Vegetable Cultivation in Hong Kong. By G. A. C. Herklots. Pp. iii+86+v. (Hong Kong: The Author, The University.) 2 dollars. [11

Field Museum of Natural History. Botanical Series, Vol. 22, No. 7: Additions to our Knowledge of the American and Hawaiian Floras. By Earl Edward Sherff. (Publication 506.) Pp. 405–442. 20 cents. Geological Series, Vol. 8, No. 8: A New Phororhacoid Bird from the Deseado Formation of Patagonia. By Bryan Patterson. (Results of the Marshall Field Paleontological Expeditions to Argentina and Bolivia, 1922–27.) Pp. 49–54. 10 cents. Geological Series, Vol. 8, No. 9: Heteromyids from the Miocene and Lower Oligocene. By Paul O. McGrew. Pp. 55–58. 10 cents. Geology Memoirs, Vol. 2: The Upper Ordovician Fauna of Frobisher Bay, Baffin Land. By Sharat Kumar Roy. Pp. 212. 3.50 dollars. Zoological Series, Vol. 24, No. 24: Records of Large Fresh-Water Mussels. By Fritz Haas. Pp. 259–270. 15 cents. (Chicago: Field Museum of Natural History.) [11

Sugar-Cane Investigation Committee of Trinidad. Field Experiments on Sugar Cane in Trinidad: Annual Report for 1941. By P. E. Turner, with a Brief Description of the Sugar-Cane Soils of Trinidad, by C. F. Charter. Pp. 196. (Trinidad: Government Printer.) [11

Southern Rhodesia. Meteorological Report for the Year ended 30th June 1940. Pp. 58. (Salisbury: Government Stationery Office.) [11

Indian Lac Research Institute. Annual Report for the Financial Year 1940–41. Pp. v+41. (Namkum: Indian Lac Research Institute.) [11

Smithsonian Miscellaneous Collections. Vol. 101, No. 5: On Solar Constant and Atmospheric Temperature Changes. By Henryk Arctowski. (Publication 3641.) Pp. vi+62. (Washington, D.C.: Smithsonian Institution.) [11

Catalogues

Rotameters: British Made Precision Flowmeters for all Gases and Liquids. (RM.120/1.) Pp. 6. (Portslade: Rotameter Manufacturing Co., Ltd.)

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SCIENTIFIC ORGANIZATION OF SOCIAL ACTIVITIES

EXPERIENCE has indicated that some of the economic and social activities of a nation cannot safely be left to unguided individual initiative or interest. Education has long been reckoned as such a social activity, and most of the effort required to supply the essential needs comprised in the idea of the social minimum and embodied in what has been described as a new Bill of Rights for the citizen might be placed in the same category. Mr. Geoffrey Crowther, editor of the *Economist*, in an article in the American periodical *Fortune*, goes so far as to suggest that all activities connected with the supply of the nation's food, including production, as agriculture, and distribution and processing, should be planned and controlled by the nation in order that the new standards of nutrition, etc., may be secured. The magnitude of the problem suggests at once that it is by no means easy to draw a line beyond which the profit motive should not be permitted. It may be conceded, for example, that public health is definitely a matter for purposeful organized effort on behalf of the community and cannot be left to the operation of the profit motive. The implications of such a policy, however, are far-reaching and not all obvious. National health is the product of many factors, and some of them, not the least important, owe their primary stimulus, not necessarily, indeed, to the motive of profit or private gain, but certainly to that element of freedom which Mr. Crowther suggests should in theory be excluded from the social field.

The health of the community does not depend only on the general state of nutrition and the standard of living, including all those environmental factors involved in town and country planning, recreation, the location of industry, industrial welfare and the like, and on the social services, such as the health services themselves, whether preventive or remedial. These activities are clearly those which should be planned and run by the community with no consideration of profit and with the main object of effective service to the needs of the community. The public health depends further on the prosecution of scientific research, not merely into nutrition but also into the prevention and cure of disease, and it is at this point that, as is indicated by Sir Henry Dale's recent presidential address to the Royal Society and the recent announcement of the formation of the Therapeutic Research Corporation, there is a definite need for a mixture of the motives of freedom and service. Sir Henry Dale laid the major stress in his address on the importance of freedom and opportunity rather than organization as providing the conditions for the highest type of research. None the less he recognizes the necessity of organization if discovery is to be put to full use, and his example of the association of science with the State without weakening the freedom of the scientific worker so happily illustrated by the Medical Research Council indicates that balance between order and freedom for which Mr. Crowther pleads. Sir Henry holds that the existing mechanisms for the support of science by the State, while susceptible of improvement, offer no threat to the freedom of science, nor does the wider use of the organized application of science and scientific method to problems of public welfare, or the more effective access of scientific knowledge to those responsible for government.

The train of thought started by Sir Henry Dale and Mr. Crowther thus raises the very pertinent question as to whether the organization of medical and pharmaceutical research is not a matter for the State acting on behalf of the community, and whether after the War the field of activity of the Medical Research Council should not be extended so as to remove or limit considerably the operation of the profit motive in this field. The subject is one which is ripe for fuller consideration, but it must be remembered that in this field the past experience of Government organization or direction does not warrant undue optimism as to the advantage of a radical change in policy. The related field of industrial health supplies a pertinent example.

A recent report of the Select Committee on National Expenditure commented on the neglect to make full use of the Industrial Health Research Board for the scientific study of questions affecting industrial health and the best use of labour. The Government comment on a specific recommendation regarding investigations on the best length of the working week, while accepting as a basis for action the results of the Board's investigations, and indicating that it is proposed to obtain information as to sections of industry or particular kinds of work into which the Board might make further investigations, does not touch the root of the Select Committee's criticism—the inadequate resources and staff of the Board. On this point the recent report of the British Medical Association's Committee on Industrial Health in Factories is far from reassuring; that it should be possible for such a report to characterize industrial health research as on the whole sporadic and unco-ordinated, reflects neither to the credit of Government or people.

The B.M.A. Committee is clearly right in holding that further effort is required to place industrial health research on an adequate and efficient basis. If we have due regard for the national health, we cannot tolerate a system which fails to provide essential staff for the Industrial Health Research Board, or requires its paid secretary to act also as chief medical officer to the Ministry of Supply, and relies too much on incidental research of the medical inspectorate of factories. In the absence of driving force from the Government, we cannot be content to leave research in this field to the medical departments of individual firms.

Whether a fresh organization should be established for this purpose, as recommended by the B.M.A. Committee, is quite another matter. The logical method would be to develop the national organization which already exists, and extend the work and resources of the Industrial Health Research Board, linking up its work with regional schemes or organizations covering particular industries as required. The contacts already established with individual firms should provide a starting-point or nucleus for further development, and the co-ordination and application of the knowledge already available is unquestionably a matter for the State.

There will be general agreement with the Committee as to the urgency of the matter, and if preoccupation with other matters is the only legitimate explanation, though no excuse, of the Government's neglect of the many problems in this field of the utmost importance to the nation's health that are awaiting solution, the stimulus must come in the first instance from the professional workers concerned. Not merely the medical practitioner but also others concerned with the problems of industrial health—the manager, the chemical engineer, the plant superintendent, the chemist, the labour manager, individually and through their professional associations, must address themselves to the task of educating both the Government and Parliament, as well as the nation at large, to the importance and urgency of these questions from the point of view of our maximum war effort as well as of the long-term health of the nation.

It is, indeed, on the faithfulness and earnestness with which scientific workers turn to this and like tasks of education that the effectiveness of reconstruction and the wider possibilities of a new order largely depend. Reconstruction and the new order to be established after the War will be conditioned—and limited—by the extent to which public opinion is prepared for the necessary changes and understands what is involved. The contribution of the scientific worker in this task of education is, indeed, far more vital than any contribution he may make in the actual administration of the schemes put into operation. Scientific workers as such have no special claims for administrative responsibilities, though their scientific qualifications should not, as so often happens, debar them from administrative office when they clearly possess, in addition, administrative ability. They do carry, however, a special responsibility for sharing in the task of educating the community to an intelligent understanding of the technical or scientific factors involved in public problems concerning health or in any other field.

The report of the Committee on Industrial Health in Factories, and also the formation of the Medical Planning Commission, show that the British Medical Association has under consideration a number of these urgent problems. Some other professional associations, such as the Royal Institute of British Architects the Institute of Physics and the Institutions of Civil and of Mechanical Engineers, are also seeking to focus attention on the problems that lie immediately ahead. There are other categories of scientific workers who are far from showing signs of being asleep, even on matters not intimately connected with their own profession. The report on industrial health in factories, for example, contains the rather naïve suggestion that an industrial medical officer should be responsible directly to the managing director of his firm, and its proposals for a central advisory body to guide employers in making appointments may well meet with some criticism from within the profession.

It must, in fact, be admitted that scientific workers and other professional men are not necessarily able to take detached or objective views on matters of public policy that affect their own interests, nor even to apply scientific methods to problems outside the highly specialized field in which they are themselves engaged. No less than other sections of the community, they require educating, at least in outlook, and their professional associations, taken as a whole, are representative of conservative rather than of progressive elements. The responsibility for undertaking the task of education, whether within or without the ranks of the profession, lies the more heavily accordingly on the shoulders of those scientific and professional men who are awake to the needs and implications of the present situation. Whether or not the hopes that have been raised of a new and more bounteous world order are to be realized depends largely on the way in which this task of education is undertaken now. The Conference on Science and World Order held last September, the Conference on Science and the War Effort held in January, and the formation of the Medical Planning Commission of the British Medical Association are welcome signs that the task is already being undertaken.

MODERN THEORIES OF ORGANIC CHEMISTRY

Modern Theories of Organic Chemistry

By Dr. H. B. Watson. Second edition. Pp. viii+268. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 17*s.* 6*d.* net.

AT the present time organic chemistry is enjoying one of its recurrent periods of profuse activity: an activity manifest in two main directions. In the first, great and impressive advances are being made in the difficult task of unravelling the molecular structures of complex compounds of profound physiological and biological significance. A second characteristic feature of modern organic chemistry is its growing concern with the mechanism of reactions, and great efforts are being made to reach an understanding and eventual solution of this group of problems. In their elucidation the methods of physical chemistry and of physics find as much, if not more, application than do the classical methods of organic chemistry.

This peaceful penetration of the rich and fertile provinces of organic chemistry by the ideas and experimental methods of physics and physical chemistry has been steady and persistent during the last few decades, while in more recent years the pace has quickened. Both branches of chemistry have gained thereby and abundant material becomes available for an interesting story.

The four years which have elapsed since the publication of Dr. Watson's well-known volume have witnessed notable developments on the theoretical side of organic chemistry, and concise summaries of these have been woven into the fabric of the new edition now under review. The new edition, however, does more than incorporate new material: large sections have been carefully re-written and reference rendered easier by the more abundant use of sub-headings. Further, the order of treatment of various subjects has been revised, leading to improvements both in classification and logical sequence. Topics formerly omitted or merely mentioned in passing, probably being regarded as in too early a stage of development for a balanced review in the old edition, now take their appropriate place in this admirable survey, which covers a wide field in considerable detail. Despite its detail, it is a most readable book; its perusal is greatly helped by clearness of print and orderly arrangement of formulæ. The opening chapter now includes an extension of the earlier section on quantum mechanical resonance and its application to resonance between different bond structures, mesomerism and the stability of the hydrogen bond.

Chapter 4 includes notes on electron diffraction and molecular magnetism, particularly valuable in view of the important parts which these methods may be destined to play in the elucidation of molecular structure. The discussion of dipole moments, now arranged in a more coherent manner, is included in this chapter and its value enhanced by the inclusion of some of the more recent results brought to light by this line of inquiry. Similarly, the general discussion on the applications of the electronic theory of valency to organic chemistry, now forming Chapter 6, is arranged in better order and includes a description of the most recent experimental results and speculations; the account of mesomeric, electromeric and inductomeric effects, rather involved in the old edition, has been clarified and amplified.

A new chapter on esterification and hydrolysis gives an outline of the development of the current theories of these reactions; while the interesting subject of simple substitution reactions in aliphatic compounds, so exhaustively investigated during the past few years by Ingold, Hughes and their co-workers, deservedly receives full discussion in a further new chapter.

The chapter dealing with reactions in which the primary process involves addition to unsaturated compounds is enlarged and describes modern views on the mechanisms of the Knoevenagel, Perkin, Claisen and aldol reactions.

The increased space, now amounting to three chapters, devoted to stereochemistry is an indication of the greater interest being taken to-day by the general organic chemist in this important subject. It includes a concise but adequate account of the Walden inversion—a notable omission from the first edition but a welcome addition to the second—a discovery for long regarded as a kind of chemical Cinderella but the further investigation of which has yielded so much valuable information bearing on the mechanism of replacement reactions. This is followed by a short description of the application of kinetic methods to stereochemical problems together with a judicious review of current theories on the mechanism of reactions which involve a change of molecular configuration.

The new edition contains some fifty pages more than the old; despite this increase in size and the present difficulties of publication, the price of this excellently produced book has been raised by only half-a-crown; for this achievement the publishers deserve our congratulations.

J. KENYON.

THE MAMMALS OF INDIA

The Fauna of British India: including Ceylon and Burma

(Published under the patronage of the Secretary of State for India.) Edited by Lt.-Col. R. B. S. Sewell. Mammalia, Vol. 2: Carnivora (continued from Vol. 1), Suborders Æluroidea (part) and Arctoidea. By R. I. Pocock. Pp. xii+504+12 plates. (London: Taylor and Francis, Ltd., 1941.) 35*s*.

THE volumes on mammals by Blandford in the first edition of "The Fauna of British India", have long been out of date and the large amount of new material has called for a new edition. Mr. R. I. Pocock, whose knowledge of the subject from long experience, both at the British Museum and the Zoological Gardens, is second to none, has now produced the second volume of the second edition, the first, by the same author, having been reviewed in NATURE of February 3, 1940, p. 164.

As in Vol. 1, the author has shown great thoroughness and an infinite amount of careful research. He continues with the order Carnivora, commenced in Vol. 1, and deals with the families Herpestidæ, Hyænidæ, Canidæ, Ursidæ, Ailuropodidæ, Ailuridæ and Mustelidæ. One is struck by the minuteness of the details investigated by Pocock, who has not overlooked characters which former authors, with less opportunities, have missed; and not only has he described such characters, many of which have proved of value in classification, but he has also skilfully illustrated them by line drawings, those of the soft parts being mostly from fresh specimens that had died in the Zoological Gardens. His drawings of the whole animals are also very good and show the characteristic attitudes and markings of species of which no photographs are available; but it seems a pity to adopt this method of illustration where good photographs could have been obtained, such as in the case of the giant panda.

Of this strange and interesting animal the author has a good deal to tell us, though he admits that it has not yet been discovered within the precincts of British India. It was, however, referred to by Blandford in the original edition of the present work, and there seems a possibility of its turning up in the near future in Upper Burma. Moreover, we are told of a closely allied and recently extinct species of which a complete skull was found in Upper Burma.

The arrival in Great Britain of living specimens of the giant panda a few years ago caused no little sensation, as it was supposed to be one of the rarest mammals in the world. It is a carnivore that has adopted an entirely vegetarian diet, its principal food consisting of the shoots and stems of bamboo up to half an inch or so in diameter which its powerful jaws enable it to chew with ease. It was interesting to watch the method of feeding adopted by those at the Zoo, and to notice the way the shoots were firmly held in a front paw as easily as a monkey holds food in its hand. In order to enable this bear-like creature to use its front feet as hands these have been modified by the provision of "an accessory lobe which covers the tip of a slightly movable elongated bone developed from the carpus and lying alongside the metacarpus of the first digit, and completely enveloped in the skin of the paw so as to be entirely invisible without dissection".

In a book of this sort, containing as it does a mass of detail invaluable to systemists though less interesting to the general reader, it is good to find full accounts of the habits of the animals where these are known.

Mongooses are represented in India by a number of species the habits of which seem to be very much the same in all. They somewhat resemble stoats in being alert, usually fearless creatures with the habit of sitting erect on their hind quarters to increase their range of vision. They are superior to cats in the matter of vermin killing, as they can enter the burrows of their prey and dig it out, and they fearlessly attack snakes and other pests which cats will not deal with. If captured young they are easily tamed and prove most efficient agents in destroying rats, snakes, scorpions and other objectionable intruders. It was the small North Indian species that was, in 1872, introduced into Jamaica to combat the pest of rats which inflicted great damage on sugar cane plantations. The experiment proved eminently successful in reducing the numbers of the rats and was adopted by planters in adjoining islands. But the author does not mention the regrettable effect this introduction had upon the interesting avifauna of the islands, many of the ground-frequenting birds being virtually exterminated, while, it is said, the rats soon commenced to develop tree-nesting habits and so saved themselves from utter extermination from the mongooses, which are not good tree-climbers.

As a snake-killer the mongoose is greatly valued in India since it fearlessly attacks poisonous as well as non-poisonous kinds. It is not, we are told, immune to the effects of snake poison as has been asserted, but it almost invariably succeeds in evading the deadly fangs chiefly by its extreme activity in dodging the reptile's strokes. It is aided, too, by the long hairs of its body, which, during an encounter, are all erected, making its apparent bulk more than doubled, and it presents to the snake's aim a large area through which the fangs pass harmlessly.

The origin of the domestic dog has always been somewhat of a mystery though its affinity to the wolf has never been doubted. The author considers it a certainty that the wolf is the principal if not the sole ancestor, though admitting that the view that the jackal may have contributed to the strain cannot be dismissed, considering that some of the dogs possessed by Neolithic man were comparatively small. As the author remarks, "there is no mistaking the stamp of the wolf on such breeds as the Alsatian and the Eskimo", but it is difficult to imagine this ancestry in the case of the Pekingese or Griffon.

This book will long remain the standard work on the very rich mammalian fauna of the countries with which it deals. D. SETH-SMITH.

THE PRINCIPLE OF RELAXATION

Relaxation Methods in Engineering Science

A Treatise on Approximate Computation. By Prof. R. V. Southwell. (Oxford Engineering Science Series.) Pp. vii+252. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 17s. 6d. net.

THOSE who heard Prof. Southwell's lecture to the London Mathematical Society in 1937 will well remember how he communicated to his audience some of the great enthusiasm with which he had reacted to the method of relaxation, first advanced by Prof. Hardy Cross in 1932, and introduced to Great Britain by Prof. J. F. Baker, J. Morris and D. Williams (Aeronautical Research Committee, R. & M., 1667, 1670 and 1672). The great attraction of the method is that the engineering problem of estimating the stresses in a redundant steel framework is solved by a process of successive approximation, each step in which represents a definite engineering operation on the framework.

Imagine each joint fixed in position, and orientation by suitable jacks. As the prescribed loads are applied to the structure, the jacks are called upon to supply greater and greater constraining forces. Now ease off the jack carrying the greatest load, until it provides no constraint. The loads on the jacks holding the adjacent joints will change and so will the stresses in the adjacent members. Choose the jack which now carries the greatest load and ease *that* one off. It is evident that by this process we are approaching the condition in which no jack provides any constraint. Now Hardy Cross showed that the redistribution of loads and stresses due to slacking off one jack is easily calculable for an unbraced framework precisely because only adjacent joints and members are affected; and Morris and Southwell have extended his method to braced frameworks including members with end loads. We have therefore a method of successive approximation to the stresses in a given framework when no external forces constrain the joints. As Southwell said in his lecture, "You can describe this process in mathematical language, but when I talk about relaxation I can see the workmen at the jacks spitting on their hands".

The method of systematic relaxation, as developed and applied by Southwell, has become one of the most important methods of practical computation in modern engineering science. Its scope is by no means restricted to those problems of redundant structures in which it attained its first successes. In the hands of Southwell and of the school of research workers which he has established at Oxford, relaxation methods have been successfully applied to a bewildering variety of difficult and outstanding problems of plasticity, conformal transformation, vibrating systems, percolation and the like. Many of these applications are described in the present volume. Naturally, these advances have to be purchased at a price—that of careful and laborious computation according to the systematized process developed by Southwell—but, in the words of one of Southwell's students, "The method works if the computer is prepared to".

The present volume gives a masterly account of the applications of the relaxation method, and is invaluable for the engineer who is well acquainted with the mechanics of frameworks. But, if I may be allowed a personal criticism, I found it a difficult book to read. I think this difficulty arises because the reader is faced simultaneously with an entirely new method, and with somewhat specialized problems of stressing, vibrations, etc. What is really required is an introductory chapter explaining the essence of the relaxation method, a chapter which should be entirely abstract and mathematical and unencumbered by the details of practical problems.

The possibility of writing such an introduction arises from the fact that, to the eye of the mathematician, most of the early problems tackled by relaxation methods reduce in the last analysis to the solution of a set of linear simultaneous equations, while the practical difficulty of computation is due to the fact that the number of independent unknown variables is large, for example, a dozen or more.

Various methods of successive approximation have been devised for the solution of this type of problem, such as the powerful iteration methods due to Morris. Many (if not most methods) including the relaxation methods, require the system of linear equations to be "prepared" for computation by being reduced to the "normal" form. In this form the equations represent the conditions that a quadratic form in the unknowns should be an absolute minimum. This simple remark leads to a geometrical interpretation of the relaxation method, which is most easily visualized in the simplest case when there are only two unknowns.

The quadratic form to be minimized then represents the contour of a valley, the unknown variables being interpreted as latitude and longitude, and the numerical value of the quadratic form as height above sea-level. To minimize the quadratic form is to reach the lowest point in the valley in a thick mist, with no map, but having a compass. Southwell's relaxation method directs the lost explorer to walk downhill due north (or south) until the track he is following becomes momentarily level. Then to walk downhill due east (or west) until his track again becomes momentarily level; and thus to zig-zag down the valley sides until he is sufficiently near the absolute bottom part of the valley.

The method is delightfully simple and it suggests an obvious alternative. Instead of taking the direction of each walk to be due north or east, the explorer can take each walk in the direction of the line of steepest descent at the starting-point of each walk, and can continue the walk until the track he is pursuing becomes momentarily level. This procedure smooths out the zig-zags of the relaxation method; and for some time I thought that the method of steepest descent was an improvement upon the original relaxation method. A direct comparison of the two methods on the same problem soon showed, however, that the original relaxation method is much easier to apply and slightly more rapid.

An introduction on some such lines as these would, I think, be a great help to the novice—and most of us are novices when confronted with the type of problem discussed in this book. But, apart from this suggestion, the present work is above criticism, and Prof. Southwell has made us all his debtors by making his pioneer researches on relaxation methods available in such a convenient and delightful form. G. TEMPLE.

TORSIONAL VIBRATION PROBLEMS

Practical Solution of Torsional Vibration Problems
With Examples from Marine, Electrical, Aeronautical and Automobile Engineering Practice. By Dr. W. Ker Wilson. Second edition. Vol. 2. Pp. xxi+694. (London: Chapman and Hall, Ltd., 1941.) 42*s.* net.

THE objective treatment of the subject of torsional vibration which has been adopted by Dr. W. Ker Wilson leads inevitably to the call for more and yet more examples of the practical solution of problems such as arise in this increasingly important branch of the designer's work. The original single-volume treatise has now been enlarged to two very substantial volumes which greatly increase the scope of the work. This at the same time gives opportunity for the re-writing of sections such as that dealing with damping devices, which has been brought up to date and now includes a separate chapter on the rotating pendulum vibration absorber.

The second of the two volumes has recently been published, and the main feature of the presentation of the subject lies in the solution of problems met with in practice. It is, however, very far from being a fortuitous assortment of examples of this class of work, as there is a logical sequence of development of the subject. The volume opens with the determination of stresses due to torsional vibration at resonant speeds, and proceeds to the measurement of amplitudes, analysis of torsiograph records, damping and absorbing devices and dynamic characteristics of direct-coupled electrical generating sets.

There are some thirty worked examples which appear in their natural sequence in this order of treatment. The examples showing the harmonic analysis of vibration records, using 24 and 48 ordinates, provide a valuable guide to the solution of such problems when a mechanical analyser is not available. It may be confidently stated that Dr. Wilson's book will do much to simplify the application of vibration study to modern needs.

University Physics

By Dr. F. C. Champion. Part 3: Light. Pp. vii+172. 5*s.* 6*d.* net. Part 4: Wave-Motion and Sound. Pp. vii+67. 5*s.* net. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1941.)

THESE two books form part of a complete course in physics for university students. Both books are clearly and soundly written, and are excellently produced. There is a group of examples after each chapter, and at the end of each book there is a number of questions with answers and useful hints for solution.

"Light". In a book avowedly written for university students, and occupying only 172 pages, it is rather surprising to find space taken up with elementary work. Certain sections are marked with an asterisk indicating that Intermediate students may omit them, but not everybody will agree with Dr. Champion's selection of the parts to be omitted. The chapter on photometry is very good, though probably more information might have been given on photo-electric instruments, while the chapter on the emission and wave theories of light is excellent and makes one wish for more.

"Sound". In this book, which runs to only 57 pages of text, Dr. Champion starts with a treatment of wave motion and simple harmonic waves. This is an excellent beginning, but as one goes through the book one finds that in many cases just the basic information is given. This is probably the author's intention; nevertheless the students for whom the book has been written will require more.

Undoubtedly what Dr. Champion has given is excellent, but he has not given enough; a bibliography of reference books would probably have been helpful to students.

Mathematics for Engineers

By Raymond W. Dull. Second edition. Pp. xviii+780. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 35*s.*

THIS is the second edition of the author's treatise on mathematics designed for engineers. It was originally published in 1926 and the major change in this new issue lies in the addition of several new operations with the slide rule—which the writer calls the "engineer's assistant"—made possible by modern improvements in the design of that useful instrument. The course is intended to bridge the gap between the engineer's handbook and the purely mathematical text-book, the former being too concise and incomplete, while the latter is too specialized. Considerable space is assigned to the treatment of error—absolute and relative—and to practical use of the slide rule.

The artificial boundaries between the various branches of the subject are commendably swept aside and, between the simple arithmetic of the first chapter and the multiple integration of the last, there is, in the intervening fifty-five chapters, a comprehensive and practical review of algebra, pure and analytical geometry, mensuration, trigonometry, ncluding complex numbers, and calculus. The text s well illustrated by worked examples and clearly drawn diagrams. A few minor misprints are noticeable in which the phrase, "knots per hour", may be be included. As a review and work of reference, the book should be quite useful to those for whom t was written.

F. G. W. B.

The Foundations of Geometry

By Prof. Gilbert de B. Robinson. (Mathematical Expositions, No. 1.) Pp. xi+167. (Toronto: University of Toronto Press, 1940.) 2 dollars.

THERE are several excellent treatises dealing exhaustively with modern ideas of geometry and analysis, but the bulk and difficulty of these works repel those who are not specialists. The University of Toronto is publishing a series of "Mathematical Expositions", which will present topics in a readable fashion, with particular attention to showing how modern theories of mathematics arise naturally from considerations well known to elementary students. The first volume, Prof. Robinson's "The Foundations of Geometry", carries out this programme so far as it concerns the more usual kinds of geometry, leaving non-Euclidean geometry to be dealt with in a later volume. Part I considers the axiomatic foundation of projective geometry and of Euclidean geometry, and shows the relation between these. Part II deals with the more difficult questions of number, order and continuity. Those with a good knowledge of school geometry should find the book very helpful as a bridge between the old domains and the new.

Future volumes in this series will include "The Infinite in Mathematics" and "The Theory of Interest".

Opera hactenus inedita Rogeri Baconi

Fasc. 16: Communia Mathematica Fratris Rogeri. Partes prima et seconda. Nunc primum edidit Dr. Robert Steele. Pp. xii+162. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 15*s.* net.

ROGER BACON (1214–1294) produced in 1267 his four-volume Latin encyclopædic treatise ("Opus Majus") on the foundations of knowledge, with two supplements dealing with physical science and mathematics. The "Communia Mathematica" appears to be an amplified version of the second supplement, assembled from various manuscripts by someone unknown, probably about 1428. For the modern reader the interest of the work is mainly in showing what mathematical literature and teaching were available at the time, and what Bacon thought of the teaching of Boethius, who moulded scientific thought of the early Middle Ages until the complete acceptance of Aristotle's physics. The first part of the "Communia" deals with the relation of mathematics to other branches of learning. The second part considers certain parts of mathematics in detail, particularly the theory of proportion. The criticism of some of Euclid's assumptions and definitions shows that Bacon was far in advance of this time. As is well known, he was accused of magic and condemned to imprisonment for life.

Differential Equations

By G. S. Diwan and Prof. D. S. Agashe. Pp. x+316. (Bombay: Prof. D. S. Agashe, St. Xavier's College, 1941.) n.p.

THIS book, intended for a first degree course in Indian universities, gives a rather detailed account of the usual devices for obtaining a compact solution of differential equations designed to yield to the appropriate device. For this purpose it may be found useful.

L. M. M.-T.

MECHANISM AND CHEMICAL KINETICS OF ORGANIC REACTIONS IN LIQUID SYSTEMS*

By DR. E. D. HUGHES
University College, London

THE theory of chemical kinetics owes much of its development to the ease with which organic reactions lend themselves to convenient measurement, but the debt has been amply repaid, for kinetic studies have contributed very materially to the elucidation of the mechanism of organic processes. The importance of the kinetic method in the study of mechanism was demonstrated many years ago, particularly by Lapworth, Orton and others in the early years of the present century. More recently, it has been given enhanced value by the important advances in the physical interpretation of kinetic data (especially in liquid systems), and it has played a notable part in the rapid development which the theory of organic reactions has undergone since the enunciation of the electronic theory of valency. Of the conclusions derived from investigations in this field in the last decade, one of the most important, and one which is widely illustrated in this discussion, is that a reaction may follow different mechanisms in not very drastically altered circumstances. This fact emphasizes still further the importance of kinetic control in the study of reactions. With the aid of kinetics, chemical behaviour can be related to mechanism and its determining factors, chemical structure and physical conditions, and the solution of outstanding problems can thus be greatly facilitated.

The reactions which come under review involve three main processes which are quite closely related, namely, substitution, elimination and addition. The substitution reactions may be divided into three principal types, as illustrated in the following table (the dots in the formulæ representing electrons)[1]:

TYPES OF SUBSTITUTION.

(*A*) **Heterolytic**

(1) Nucleophilic

$$Y : + R \,|\, . . X \rightarrow Y{-}R + : X \;.\;.\;.\;.\; (S_N).$$

(example : $H\bar{O} + R{-}Cl \rightarrow HO{-}R + \bar{Cl}$)

(2) Electrophilic

$$Y + R \;.\;.\, | X \rightarrow Y{-}R + X \;.\;.\;.\;.\; (S_E).$$

(example : $\overset{+}{D} + R{-}H \rightarrow D{-}R + \overset{+}{H}$)

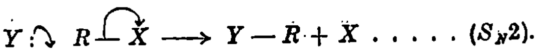
(*B*) **Homolytic**

$$Y . + R . | . X \rightarrow Y{-}R + . X$$

(example : $D + H{-}H \rightarrow D{-}H + H$).

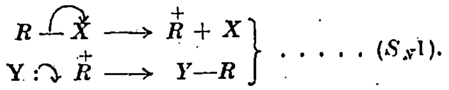
The mechanism of reactions related to the first of these types will now be discussed; reactions of the second and third type are considered in the sequel.

In a simple nucleophilic substitution[1], of the form $Y + R{-}X \rightarrow Y{-}R + X$, the nucleophilic reagent Y, whatever its original charge, must become one unit more positive; and the expelled group X one unit more negative; Y may therefore be either negative or neutral (for example, $\bar{I}$, $\bar{O}H$, NR_3, SR_2, etc.), and X either formally neutral or positive (for example, Cl, $\overset{+}{N}R_3$, $\overset{+}{S}R_2$, etc.). The kinetics of these reactions call for the recognition of two distinct mechanisms. The first is a one-stage process, which is termed 'bimolecular' because two molecules are undergoing covalency change:



$$Y : \curvearrowright R \!-\! \ddot{X} \longrightarrow Y - R + \ddot{X} \;.\;.\;.\;.\;.\; (S_N2).$$

(In this formulation, and elsewhere in this article, arrows are used to show the direction of electron displacements; sign labels on X and Y have been omitted because of the various possibilities already mentioned.) The second mechanism is a two-stage process, wherein a rate-determining ionization is succeeded by a reaction between the formed carbonium ion and the substituting agent:



$$\left.\begin{array}{l} R - \ddot{X} \longrightarrow \overset{+}{R} + X \\ Y : \curvearrowright \overset{+}{R} \longrightarrow Y{-}R \end{array}\right\} \;.\;.\;.\;.\;.\; (S_N1).$$

This mechanism is termed 'unimolecular', because only one molecule ($R{-}X$) is undergoing covalency change in the rate-determining stage. The unimolecular mechanism is favoured relatively to the bimolecular mechanism by the following principal factors: (1) low nucleophilic activity in the reagent Y, (2) large electron-release from the group R, (3) strong electron-affinity in the group X, (4) high ionizing capacity in the solvent. It may also be added that the unimolecular mechanism is less sensitive to steric inhibition by substituent groups than is the bimolecular mechanism. When the reaction centre is asymmetric, the bimolecular mechanism invariably leads to inversion of configuration, while the unimolecular mechanism may give rise, depending on structural influences, either to retention of configuration or to racemization with predominating inversion.

For certain simple substitutions of the type now considered, Polanyi and others have calculated the activation energies to be expected on the basis of the above mechanisms. The values thus deduced are in reasonably good agreement with the experimental results. In the case of the 'symmetrical' halogen-exchange reactions (bimolecular), for example, $\bar{Cl} + CH_3.Cl \rightarrow Cl.CH_3 + \bar{Cl}$, a very simple method of calculation has now been described[2]. In first approximation, the activation energy is taken as the energy necessary to extend the carbon – halogen bond until it has the length corresponding to a carbon atom and a halide ion in contact, and it is shown that the introduction of various refinements into this procedure does not materially affect the result.

The same fundamental mechanisms operate in aromatic side-chain substitution[3], but interesting differences of behaviour are sometimes observed when the polar effects of certain substituents in the nucleus are compared with the effects of the same substituents when attached to a saturated system. With alkyl groups, for example, the predominating influence with respect to a reaction in a saturated system such as the replacement of halogen in an organic halide, $R—CR'_2—Br$, by the usual mechanisms (S_N1 and S_N2), is the general 'inductive' effect, which increases from left to right in the series, $R = CH_3$, $CH_3.CH_2$, $(CH_3)_2CH$, $(CH_3)_3C$; thus $CH_3 \rightarrow CH_2 \rightarrow CR'_2 \rightarrow Br > CH_3 \rightarrow CR'_2 \rightarrow Br$. When the unsaturated aromatic nucleus is interposed between the alkyl group and the reaction centre, however, another effect gains in importance and occasionally becomes the dominant influence; this is the 'electromeric' effect, which arises from suitably placed C—H bonds and decreases as the operative hydrogen atoms are replaced; for example:

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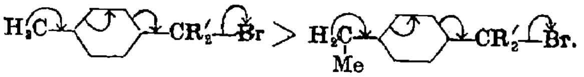
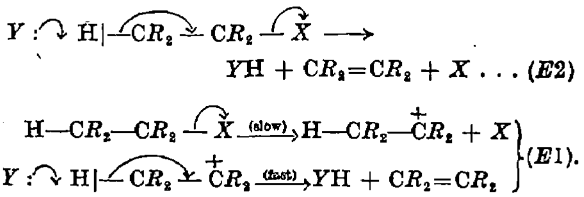
* This article is based on the Faraday Society's recent discussion on this subject (*Trans. Faraday Soc.*, **37**, 601, *et seq.*; 1941). References to the papers contributed to the discussion are given by noting the authors, employing the following key:

[1] E. D. Hughes.
[2] E. C. Baughan and M. Polanyi.
[3] J. W. Baker.
[4] E. D. Hughes and C. K. Ingold.
[5] J. N. E. Day and C. K. Ingold.
[6, 7] H. B. Watson.
[8] M. P. Balfe and J. Kenyon.
[9] G. M. Bennett.
[10] A. E. Bradfield and B. Jones.
[11] F. Fairbrother.
[12] G. Williams.
[13] W. A. Waters.
[14] J. Weiss.

A full discussion of the various topics, with literature citations, is contained in these papers.



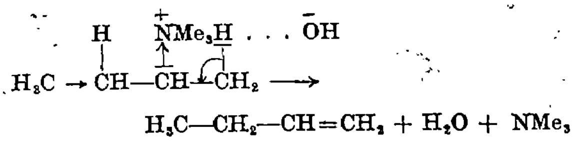
Substitution and elimination occur together so often as to suggest that the duality of mechanism established for substitution might have a parallel in the mechanism of elimination. This is found to be the case[4]. Employing the nomenclature and schematic representation already explained in connexion with nucleophilic substitution, the bimolecular ($E2$) and unimolecular ($E1$) mechanisms of elimination may be illustrated as follows ($Y = \bar{O}H$, $\bar{O}Ac$, NR_3, H_2O, etc.; $.X = .\text{Hal}$, $.SO_2R$, $.\overset{+}{S}R_2$, $.\overset{+}{N}R_3$, etc.):



$$Y: H|—CR_2—CR_2—X \longrightarrow YH + CR_2{=}CR_2 + X \ldots (E2)$$

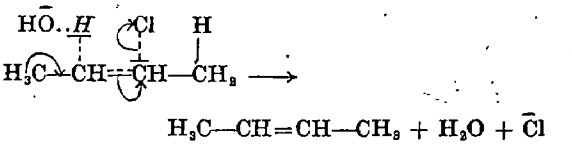
$$\left.\begin{array}{l} H—CR_2—CR_2—X \xrightarrow{\text{(slow)}} H—CR_2—\overset{+}{C}R_2 + X \\ Y: H|—CR_2—\overset{+}{C}R_2 \xrightarrow{\text{(fast)}} YH + CR_2{=}CR_2 \end{array}\right\}(E1).$$

With the recognition of these mechanisms, and with full appreciation of their relationship with the substitution processes, the apparently inconsistent observations of the older literature fall into place, and it is possible to make rationally based predictions as to the effect of chemical constitution and physical conditions on the phenomenon. Special interest is attached to the analysis of the factors governing the contrary tendencies implied in two well-known empirical rules, namely, the Hofmann and Saytzeff rules, which indicate the preferred direction of olefin elimination in alkyl 'onium salts and in branched-chain alkyl halides respectively. (The Hofmann rule refers to the preferential formation of that ethylene which bears the smallest number of alkyl groups; Saytzeff's rule, on the other hand, predicts the production of the most alkylated of the possible alkyl ethylenes.) It is found that bimolecular 'onium salt reactions are subject to the Hofmann rule, while the bimolecular reactions of halides, and the unimolecular reactions of both 'onium salts and halides, are governed by the Saytzeff rule. Furthermore, the Hofmann and Saytzeff influences are shown to be manifestations of the operation of the inductive and electromeric effects, respectively, of alkyl groups (compare preceding paragraph); for example:



$$H_3C—CH_2—CH{=}CH_2 + H_2O + NMe_3$$

The inductive effect of the β-methyl group *inhibits* the removal of a β-proton (Hofmann influences).



$$H_3C—CH{=}CH—CH_3 + H_2O + \bar{Cl}$$

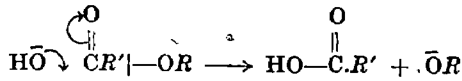
The electromeric effect of the β-methyl group *facilitates* the removal of a β-proton (Saytzeff influences).

The theory of aliphatic substitution can also be applied to the problem of carboxylic esterification and hydrolysis[5]. In this instance, it is necessary, in the first place, to distinguish between 'basic' reactions (hydrolysis in neutral or alkaline solutions) and 'acidic' reactions (acid-catalysed hydrolysis and esterification). In the former the carboxylic entity which suffers reaction is $R'.CO_2R$, while in the latter it is $[R'.CO_2HR]^+$. (In general, hydrolysis and esterification may be treated similarly; in esterification ($R = H$), however, the basic reaction is suppressed.) Secondly, there are two distinct modes of bond-fission, namely, 'acyl-oxygen fission' and 'alkyl-oxygen fission'; and, in both basic and acidic reactions, either the one or the other may take place according to circumstances. There are thus four main types of reactions, which, with respect to the carboxylic entity and its mode of fission, may be represented:

	Basic Reactions	Acidic Reactions
Acyl-oxygen fission:	$R'.CO|—O—R$	$[R'.CO|—OH—R]^+$
Alkyl-oxygen fission:	$R'.CO—O—|R$	$[R'.CO—OH—|R]^+$

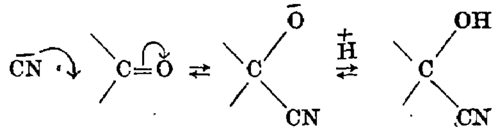
In esterification ($R = H$), there is a corresponding fission in the alcohol, that is, $R—O—|H$ (in acyl-oxygen fission) and $R|—O—H$ (in alkyl-oxygen fission). Finally, it would appear, from the rather limited amount of suitable kinetic data, that, for certain of these reactions, two mechanisms exist which are related to each other just like the unimolecular and bimolecular mechanisms of simple nucleophilic substitution.

As in certain of the reactions involved in carboxylic esterification and hydrolysis, for example,

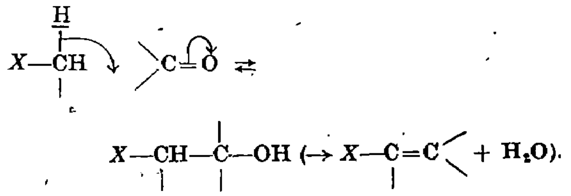


$$H\bar{O}\ \overset{O}{\overset{\|}{C}}R'|—OR \longrightarrow HO—\overset{O}{\overset{\|}{C}}.R' + .\bar{O}R,$$

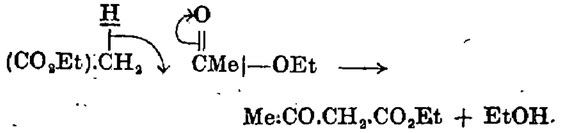
the addition and condensation reactions of carbonyl compounds[6] are dependent on the reactivity, towards nucleophilic reagents, of the carbon atom of the carbonyl group. A simple example is to be found in cyanohydrin formation, the mechanism of which was clearly indicated by Lapworth's classical kinetic investigations:



while reactions of the Aldol, Claisen, Knoevenagel and Perkin type follow a similar, though somewhat more complex, plan, for example:

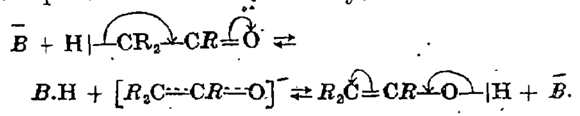


The Michael and the Thorpe reactions typify a quite analogous addition of a nucleophilic reagent to suitably activated C=C and C≡N bonds respectively.) All these reactions have certain features in common; thus they generally exhibit both alkaline and acid catalysis, and, while one of the reactants is a carbonyl compound, the second component contains a labile hydrogen atom which is activated by at least one electron-attracting substituent (*X*). The function of the basic catalyst is to remove the proton, thereby creating a more powerful nucleophilic reagent, and there is kinetic evidence that this reaction may, in certain cases, constitute the rate-determining stage of the process. An acid catalyst, on the other hand, probably activates the carbonyl component by forming an oxonium complex, $>\text{C}=\overset{+}{\text{O}}\text{H}$. Reactions of the type of the acetoacetic ester condensation are also similar, and the analogy with the alkaline hydrolysis of esters is even more striking in this case:



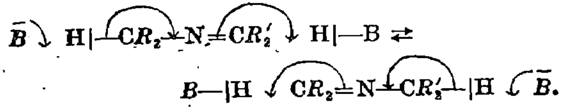
$$(\text{CO}_2\text{Et}).\text{CH}_2\text{—H}\ \ \text{CMe}(=\text{O})|\text{—OEt} \longrightarrow \text{Me.CO.CH}_2\text{.CO}_2\text{Et} + \text{EtOH}.$$

The protropic changes of carbonyl compounds[7], like the reactions discussed in the preceding paragraph, are catalysed both by bases and by acids. In terms of the ionic theory of prototropy, this circumstance is easily explained, for, according to this theory, the change involves the removal of a proton and the addition of a proton, processes which will obviously be facilitated by bases and by acids respectively. In the base-catalysed reaction, it is generally accepted that the first step involves the transfer of a proton to the catalyst, a 'mesomeric' anion being produced, which, by accepting a proton (for example, from the medium or the conjugate acid of the base), can form either the one or the other component of the tautomeric system:



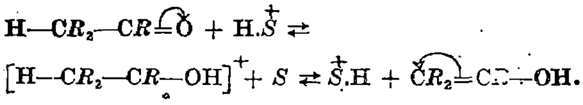
$$\bar{B} + \text{H}|\text{—CR}_2\text{—C}R=\text{O} \rightleftharpoons B\text{.H} + [R_2\text{C}\cdots\text{C}R\cdots\text{O}]^- \rightleftharpoons R_2\text{C}=\text{C}R\text{—O—}|\text{H} + \bar{B}.$$

The equality of the rates of halogenation, of protium-deuterium exchange and of racemization, which has been demonstrated for certain ketones (asymmetric at the α-carbon atom), thus receives a simple interpretation if it be assumed that the rate-determining stage in all these reactions is the formation of the mesomeric anion. Similar ideas can be applied to other prototropic systems, but in certain cases (for example, methyleneazomethines) there is evidence that the anion never attains kinetic freedom, the removal of one proton and the addition of another being simultaneous:



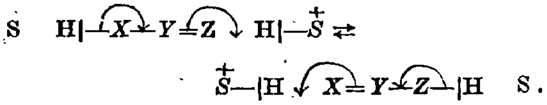
$$\bar{B}\ \text{H}|\text{—C}R_2\text{—N}=\text{C}R'_2\ \ \text{H}|\text{—B} \rightleftharpoons B\text{—}|\text{H}\ \ \text{C}R_2=\text{N—C}R'_2\text{—}|\text{H}\ \ \bar{B}.$$

In acid catalysis, the preliminary addition of a proton to the tautomeric system may facilitate the subsequent transfer of another proton from the latter to the solvent (*S*):



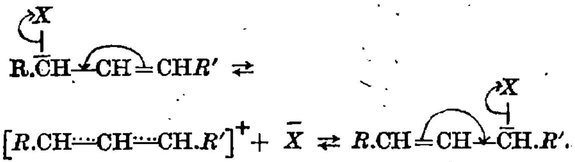
$$\text{H—C}R_2\text{—C}R=\text{O} + \text{H.}\overset{+}{S} \rightleftharpoons [\text{H—C}R_2\text{—C}R\text{—OH}]^+ + S \rightleftharpoons \overset{+}{S}\text{.H} + \text{C}R_2=\text{C}R\text{—OH}.$$

Alternatively, the proton addition and eliminatio may take place simultaneously:



$$S\ \ \text{H}|\text{—}X\text{—}Y=Z\ \ \text{H}|\text{—}\overset{+}{S} \rightleftharpoons \overset{+}{S}\text{—}|\text{H}\ \ X=Y\text{—}Z\text{—}|\text{H}\ \ S.$$

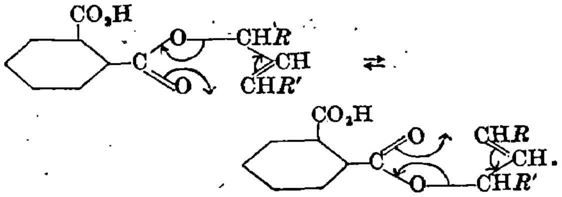
Anionotropic change[8] is, in some respects, simila to prototropic change, and it is also related t nucleophilic substitution. In anionotropy we ar concerned with the movement of negative groups and there is evidence that the interconversion ma proceed through the intermediate formation of positive mesomeric ion and a complementary negative ion; for example,



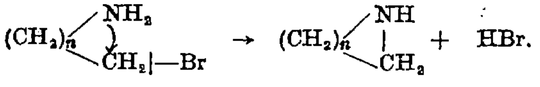
$$R\text{.CH}X\text{—CH}=\text{CH}R' \rightleftharpoons [R\text{.CH}\cdots\text{CH}\cdots\text{CH.}R']^+ + \bar{X} \rightleftharpoons R\text{.CH}=\text{CH—CH}X\text{.}R'.$$

(. *X* = . Hal., . OH, . O*R*, . O.CO.*R*, etc.)

It has been shown that the mobility of the syste is increased by the following factors: (1) Stron electron-affinity in the group *X*, (2) large electron release from the group *R*, (3) high ionizing capacit in the medium. These are the relationships to b expected if ionization is involved, and it will b recalled that the same factors assist the ionizatio mechanism of nucleophilic substitution (S_N1). Al the facts relating to the phenomenon cannot, however, be explained on the basis of this mechanism alone. It has been shown, for example, that th anionotropic rearrangement of optically active hydrogen phthalates of substituted allyl alcohols is ofte accompanied by a high degree of retention of optica activity, and an intramolecular mechanism has bee suggested to account for this and similar observations



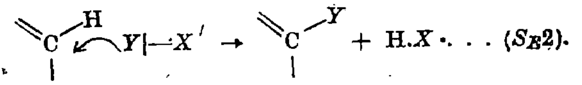
In the study of the kinetics and mechanism o ring-closure[9], the reactions which have yielded th most profitable results are mainly those which involv an internal nucleophilic substitution; for example



$$(\text{CH}_2)_n{<}^{\text{NH}_2}_{\text{CH}_2|\text{—Br}} \rightarrow (\text{CH}_2)_n{<}^{\text{NH}}_{\text{CH}_2} + \text{HBr}.$$

Since the intermolecular processes which generall accompany the cyclization involve two such molecules, and are therefore of a higher order, the bes yields of cyclic derivatives are obtained in dilut solutions. This principle has been widely exploite both in synthetic work and in the simplification o kinetic experiments. The most important aspect o this subject concerns the effect of homology, and c the notable results which have been obtained in thi connexion perhaps the most interesting relate to th great ease of formation of three- and five- (but no four-) membered rings, the special difficulty of forming rings of about nine to eleven atoms, and th alternation between odd- and even-numbered structures which is clearly exhibited in the higher members. The factors responsible for these effects are obviously rather complex, but the two most important are probably the 'distance' and 'strain' factors of Ruzicka's well-known theory, the former assisting the cyclization of short chains, and the latter favouring the formation of strainless rings.

In the replacement of hydrogen in the aromatic nucleus[10], we have a clear example of electrophilic substitution, and, since the attack of the reagent is an essential condition for the expulsion of the displaced atom (mechanism S_E2), the reaction rate will depend primarily on the electrophilic activity of the reagent and the electron availability at the reaction centre :



Concerning the reagent, it has been suggested that the efficacy of a halogenating or nitrating agent, $X.Y$ (Y = Hal. or NO_2), increases with the electron affinity of X (as indicated, for example, by the acid-strength of $H.X$) ; for example, Cl.Br > Br.Br > HO.Br ; $SO_4H.NO_2(a) > H_2\overset{+}{O}.NO_2(b) > AcO.NO_2(c) > HO.NO_2(d) > \bar{O}.NO_2(e)$. The predicted sequence of brominating agents has been confirmed experimentally, and the order with respect to nitration is consistent with the assumption that the reagents mentioned are effective when the reaction is carried out in sulphuric acid (a), sulphuric acid or fuming nitric acid (b), acetic anhydride (c), acetic acid (or similar inert solvent) (d), and water (e).

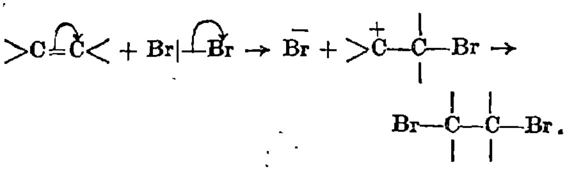
A consideration of the second factor, namely, the electron availability at the reaction centre, must take into account the 'directing' influence of a substituent group with respect to further substitution. Numerous experimental investigations and theoretical arguments concerning this problem have led to a conclusion which may be broadly summarized in the following statement : Electron-releasing groups (for example, $.CH_3$) or electron-attracting groups (for example, $.NO_2$, $.CO_2Et$) increase or decrease, respectively, the electron availability (and, consequently, the reactivity towards the electrophilic reagent) in all the nuclear positions, but more so in the o- and p-positions than in the m-position, the former groups therefore leading to a predominating o,p-substitution and the latter to m-substitution. This is well illustrated by the relative partial rates of nitration, for the various positions in benzene, toluene and ethyl benzoate, tabulated below :

	Ortho	Meta	Para
$C_6H_5.H$	1	1	1
$C_6H_5.CH_3$	43	3·0	55
$C_6H_5.CO_2Et$	0·0026	0·0079	0·0009

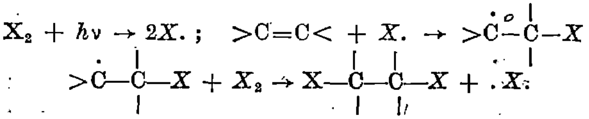
(These 'partial rate factors' are obtained by combining the figures for the total rates of nitration of the mono-substituted compounds relative to benzene (determined by a 'competition' method) with the proportions of isomerides formed.) In the chlorination of certain phenolic ethers, it has been shown that the effects of substituent groups on the reaction rate are reflected in approximately equivalent changes in the Arrhenius critical energies, and this important result has since been observed for several other reactions.

General experience relating to the effect of nuclear substituents on the Friedel-Crafts reaction[11] supports the view that it may be regarded as another example of the type of substitution discussed in the preceding paragraph. (Compare, for example, the inhibitory effect of nitro-groups ; and the difficulty of avoiding polyalkylation during attempted monoalkylation (activation by alkyl substituents), contrasted with the fact that no similar difficulty attends monoacylation (deactivation by acyl substituents). Apparent anomalies in the orientation of the substitution can be satisfactorily explained on the basis of the interconversion of products which is known to occur in the presence of the metal halide catalysts. The formation of abnormal proportions of m-derivatives in the alkylation of alkyl benzenes, for example, illustrates the tendency to form the product in which the activation of one alkyl group by the other is least, that is, the most stable isomer.) The most interesting aspect of the reaction concerns the effect of the catalysts employed, of which the most common are the halides of boron, aluminium and iron. It is now widely accepted that the most important function of the catalyst is to increase the electrophilic activity of the substituting agent by the conversion, through complex formation, of a mainly covalent carbon-halogen bond into one of essentially ionic character : $R:\ddot{Cl}:\curvearrowright AlCl_3 \rightarrow R^+[AlCl_4]^-$. Substantial evidence in favour of this interpretation has been obtained by conductivity, dielectric polarizability, and radio-isotopic exchange measurements in solutions containing the organic and inorganic halides. The electron deficiency in the alkyl component of the complex should favour the formation of secondary rather than primary, and tertiary rather than secondary, derivatives, thus accounting for the rearrangement of the alkyl group which is frequently encountered in the Friedel-Crafts reaction.

Addition to olefinic compounds[12] is related to electrophilic substitution, for, in the normal course of events, the reaction is initiated by the attack of an electrophilic reagent on the unsaturated carbon atom at which the electron density is highest. In the thermal addition of halogen in certain dissociating solvents, for example, it is well established that the following two-stage mechanism is involved :



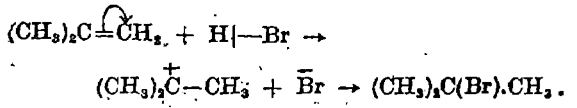
Evidence in favour of this mechanism is afforded by the effect of substituents of known polar character on the reaction rate, by the intervention of extraneous anions or a reactive solvent in the second stage of reaction (for example, bromohydrin formation in aqueous solution), and by the stereochemical data. It may be expected to function in its simplest form in dissociating solvents only, and this is confirmed by the experimental results. In non-dissociating solvents, and in the gas phase, the thermal halogenation is highly sensitive to the presence of stray catalysts, and a heterogeneous reaction involving the walls of the containing vessel often intervenes. Under these conditions the reaction is obviously very complex, and some of the observations may even indicate an atomic mechanism. The gaseous photo-addition undoubtedly involves neutral atoms and free radicals (*cf.* following paragraph), and this may also be true of the corresponding reaction in solution :



$$X_2 + h\nu \rightarrow 2X. ;\quad >C{=}C< + X. \rightarrow >\dot{C}-\overset{|}{\underset{|}{C}}-X$$

$$>\dot{C}-\overset{|}{\underset{|}{C}}-X + X_2 \rightarrow X-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-X + .X$$

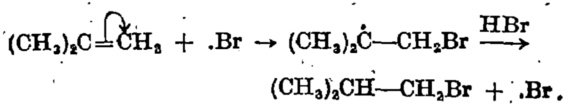
Homolytic reactions involving free radicals[13] (compare Table of Types of Substitution) exhibit some similarity to the heterolytic processes in which electrophilic reagents are concerned, because free radicals generally have depleted electron shells and tend to share an extra electron: for example, $C_6H_5. + Cl-CCl_3 \rightarrow C_6H_5-Cl + .CCl_3$. Their electrophilic character is most clearly shown in the addition reactions with olefins. In the so-called 'normal' addition of hydrogen bromide to the alkylethylenes, the proton adds preferentially to the unsaturated carbon atom bearing the smaller number of alkyl groups (cf. Markownicoff's rule), for example,



$$(CH_3)_2C{=}CH_2 + H|{-}Br \rightarrow$$

$$(CH_3)_2\overset{+}{C}-CH_3 + \overset{-}{Br} \rightarrow (CH_3)_2C(Br).CH_3 .$$

Likewise, in the peroxide-catalysed reaction ('abnormal' addition), *the addition is initiated* by the attack of a bromine atom at the point of higher electron density :



$$(CH_3)_2C{=}CH_2 + .Br \rightarrow (CH_3)_2\dot{C}-CH_2Br \xrightarrow{HBr}$$

$$(CH_3)_2CH-CH_2Br + .Br.$$

It must be emphasized, however, *that this* analogy between neutral radicals and electrophilic reagents has definite limitations. Thus, it is well known that aromatic substitution reactions of neutral radicals, for example, $Ph. + H.C_6H_4R \rightarrow Ph.C_6H_4R + .H$, do *not exhibit the usual orientation effects* associated with the heterolytic reaction. This is understandable, for the 'orienting' influence of a substituent group is due to its transmitted polar effects, which are largely dependent on the demands of the reaction *involved, and it is reasonable to suppose that the* electron displacements which are a necessary condition for an oriented heterolysis are of less importance in homolysis.

It has been shown that the Cannizzaro reaction[14] exhibits peroxide catalysis and other characteristics of a radical process, and the observations can be satisfactorily accounted for on the basis of a mechanism involving the radicals RCO and $RCHOH$, both of which are formed from the aldehyde $RCHO$ by univalent oxidation and reduction respectively.

USE OF SCIENCE AND SCIENTIFIC WORKERS IN THE WAR

THE sessions during the morning and afternoon of the last day of the Conference organized by the Association of Scientific Workers and held in London during January 10–11 dealt with the two related topics: the utilization of scientific personnel, and the application of scientific knowledge to production and Services problems.

After an introductory address by Prof. S. Chapman, in which he compared the use of science in the War of 1914–18 and in this War, Prof. W. Wardlaw spoke on the working of the Central Register. He stated that the Register has come in for a good deal of criticism but that it should be borne in mind that nearly all the persons enrolled on the Register are already in useful work from which they can only move to more important posts. The Register is intended to be a complete record of the higher administrative, professional and technically qualified personnel of Great Britain, whether employed or not. The number of engineers and scientific workers on the Register has risen from 65,000, in May 1940, to 167,000, in December 1941. It has never been the function of the Register to determine how scientific and technical knowledge should best be used in the prosecution of the War; its purpose is to meet demands for technical personnel for war purposes and to allocate the available supply in cases of scarcity. He pointed out that technical officers of full professional standing are now at the head of each section, and referred to the formation of the Technical Personnel Committee under the leadership of Lord Hankey.

Prof. Wardlaw then dealt with the new procedure of progressive de-reservation being conducted by the District Manpower Boards of the Ministry of Labour. He stated that steps are being taken to ensure that anyone with technical qualifications of Central Register standard, if not already deferred by virtue of his work, will be dealt with by the Register and placed in work which makes full use of his technical capacity, whether in the Forces or not.

Mr. E. D. Swann, of the executive committee on the Association of Scientific Workers, presented the results of inquiries by the Association into the position in the main industries in the country. It has been found that many scientific workers and engineers are not being used on war work but are engaged instead on development and design for the period of post-war competition. Others who are nominally engaged on war work have insufficient to occupy their time fully. He stated that the Essentia Works Order is being used to hold redundant staff that no mechanism exists for providing partly occupied laboratories with *further problems*, and that there is considerable duplication of work in laboratories and design departments of similar undertakings. He pointed out the need for provision for the proper pooling of information, including trade secrets. Another weakness is the notable lack of contact between the design departments of the Ministries and the design and production departments in industry. It has been found that criticism of designs from the point of view of speed and economy of manufacture is not encouraged. The Association has collected enough evidence of thi sort to press for an investigation into the utilization of our technical resources by the Select Committe on National Expenditure.

Mr. Swann then dealt with the Association's proposal that a Technical Planning Committee should be set up under the Production Executive. This Committee would deal with the technical resource of Great Britain in the same manner as the existing Industrial Capacity and Materials Committees deal with their respective resources. In this scheme it is essential that this Committee be given executiv powers. The *Association of Scientific Workers*, as i is composed of working men of science and technicians is in a position to know how effective is the present organization in practice, and it knows that it is not working satisfactorily. Central planning of scientific work is essential, and scientific committees must have contact with working men of science on the job.

The position inside the Services was considered by two speakers at some length. Prof. H. Levy stressed the vital importance of having trained men of science inside the Armed Forces. He wants to see scientific men actually at the front who could bring back all kinds of relevant information of a technical nature. He pointed out that in Great Britain scientific education is not considered in selecting personnel for the higher commands. He stressed that not only military men should be chosen, but also scientific men who have had knowledge and experience of military matters.

Mr. F. Morgan, an operational research scientist attached to an R.A.F. command, provided a first-hand review of this type of work. He described how a number of workers are drafted from research to battle centres to ensure that the best use is made of their inventions. Now these men have acquired an operational outlook and can tell their research establishment what the Command most needs; that is, they can initiate research on new equipment and suggest modification to existing equipment. But their most useful function lies in helping Command to make the best use of equipment provided. This involves education of the people who use it, statistical analysis of the ways in which it can be used, and general investigation and the arrangement of tests. He pointed out in the second connexion that his Command now analyses everything numerically from efficiency of weapons to comparison of tactics. As a result, scientific workers are able to suggest and invent manœuvres—they are no longer "amateur strategists".

Mr. Morgan emphasized the importance of methods of communication in this War, and stated that automatic equipment has not been exploited as it should. He illustrated how in the problem of night fighting, mathematicians, physicists, biochemists, psychologists and physiologists are all needed. He hopes that there will be a permanent place in the Services for such scientific field work, and suggested the formation of a central research body for all the Services, and a greater measure of inter-Service liaison. It was significant that he pointed out from the other side the tenuous connexion between operational and industrial scientific workers. Further, he asked for closer contact with their colleagues in all Allied countries. His was a thoughtful paper which made a deep impression on the Conference. In pointing out the not inconsiderable risks which this type of work involves, he expressed the grievance that there is no special compensation for dependants in the event of casualties sustained on flying duties and that promotion is slow relative to the Service rate.

A most refreshing contribution was that of Mr. T. Halse, of the Industrial Committee of the Association. After citing several of the more extreme instances where the present lack of planning has led to marked inefficiency, he dealt with the ways in which the scientific worker in industry could help better the situation. Most important of these is participation in Production Committees, whether actually in the factory or regionally. He underlined the need for the scientific workers themselves to be organized to get the best results in this direction.

There were numerous papers in which were instanced in detail and from first-hand experience bad examples of misuse or inefficient utilization of technical knowledge. Mr. R. E. Foster reported that in his laboratory, which is attached to a large aero-engine factory, most of the work consists in rechecking materials which have already been subjected to Air Ministry inspection and release. There is also a considerable amount of slack time in his laboratory, although members have been refused their release on the grounds of pressure of work. When dealing with the position in the research department of this firm he mentioned that there is insufficient allocation of funds for new equipment, lack of space, and inadequate pay for the research staff. He and his colleagues believe that production is being severely handicapped by lack of scientific planning and management, and by lack of co-operation between management and staff, and between staff workers and manual workers. Continuing, he suggested remedies, emphasizing the part of Production Committees, and calling for the national pooling of all resources of development and research and full interchange of all experimental and production data, regardless of vested interests.

The present situation in the chemical industry was considered by Mr. A. Dooley. Whereas the engineering industry is mainly based on mass-production methods, the chemical industry demands the existence of *teams* of workers, embracing manual, scientific and clerical workers. There should be no arbitrary breaking up and re-assembling of such groups, and replacement personnel should be specially trained to maintain the efficiency of the group as a whole. We can expect that the extension of the War will create a demand for substitute products and the reclamation of used material on a large scale. This will bring into active war production sections of the chemical industry which have been kept more or less in reserve.

Mr. Dooley dealt especially with the rubber situation. At the moment, in Great Britain, we reclaim only one fifth of the proportion reclaimed in the United States, and an American authority has estimated that it would take 18–24 months to construct new plants. Our capacity for synthetic replacement manufacture appears to be negligible, but we could draw on the extensive experience of the United States and the U.S.S.R. Dove-tailed planning would be necessary, and electric power on a large scale may be essential. With regard to the technical development of substitute and reclaimed material, it is important to ensure close collaboration between the Services, rubber users, research associations and the chemical industry, and this applies also to resins and textile substitutes. The problem is on too large a scale for it to be carried through effectively by haphazard methods.

A notable set of contributions were those which dealt with the protection of the health of the industrial worker. Dr. T. O. Garland in a forceful speech directed attention to the comparative indifference with which many managements have treated this question in peace-time. Recently the British Medical Association has issued a report which advocates medical supervision of workers in every factory, large or small, which should aim at reducing the general sickness rate as well as the accident rate. Dr. Haden Guest has stated that the number of medical men in industry is a very small proportion of those in the Services. Dr. Garland asked for medical men to be called up into industry as well as into the Forces. With the building of large munition factories the situation is aggravated, because the general practitioner service is not sufficient to cope with this extra work. Dr. R. O. Stanford supported this suggestion, quoting from his own experience as a medical officer at a large factory. He sketched a plan for mass-radiography of workers in order to diagnose the early stages of tuberculosis, a disease which is on the increase. Dr. D. McClean, of the Lister Institute, stressed in this connexion that all milk sold to the public should be *safe* (that is, not infected) milk.

The Oxford vaporizer, a simple apparatus for administering anæsthetics under battle conditions, was described by Dr. K. Mendelssohn, of the Clarendon Laboratory, Oxford. This vaporizer is now being mass-produced at a cost four times lower than that if bench-produced. He stressed the need for closer contact between medical men and men of science, between clinical and laboratory workers.

Dr. S. E. Hollingworth, of the Geological Survey, illustrated how geologists are often not called in when sites for factories, camps and air-raid shelters are decided upon. This has led to considerable waste when the site is badly chosen in relation to drainage and water-supply. Dr. N. F. M. Henry, of the Department of Mineralogy, Cambridge, asked for a larger place in the war effort for geologists, stating that the British Army has only two geologists. He also discussed the Malayan situation and the consequent need for using the other mineral resources of the Allied countries.

There were many other speakers in the discussions, and they represented between them a considerable cross-section of industry. Mr. F. M. H. Markham, of the Central Register, answered some of their points regarding the utilization of personnel. Although he mentioned some cases where action is being taken or being considered, the Conference seemed quite definitely to show the need on the part of official committees for consulting the junior scientific worker.

The Conference was summed up most ably by Prof. J. D. Bernal. Starting on a note of urgency, he appealed for an absence of complacency on the part of men of science with regard to what Great Britain is doing. The suggestions which were put forward at the Conference would be taken up with the Ministries of Supply and Labour, but this would not be done without opposition. This opposition would come from industry and from the Government. The first is due to the prevalence of pre-war competitive ideas; while the second is purely conservative opposition to new ideas. However, the scientific way of doing things is forcing its way against that opposition, although the attitude in many of the departments is equivalent to sabotage. Dealing with the proper utilization of our man-power, he emphasized that the only consideration in the selection and posting of personnel should be ability. We should be blinding ourselves to facts if we thought this was so at present. He referred to the contributions in the Conference which had shown a widespread feeling that these scientific workers are not fully occupied, not doing the work they can most usefully do. The mechanism that exists at present is certainly not adequate if this situation holds. The Conference is not passing any resolutions; it is instead going to take appropriate action. The Association of Scientific Workers will collate the information and suggestions, and send delegations to appropriate Ministries. Scientific workers are at last co-operatively conscious of the job they have to do in society, and they will do it, and not stop doing it, when the War is won.

OBITUARIES

Dr. Walcot Gibson, F.R.S.

The death of Walcot Gibson will recall to many the memory of a many-sided, alert and virile personality. Born in 1864, he went from Bromsgrove School to Mason College (now the University of Birmingham) at a time when Lapworth, fresh from his triumphs in the south of Scotland, had been appointed to the chair of geology. Young Gibson, his first student, fell under the master's spell and his admiration for Lapworth remained with him as an inspiration throughout his career.

Following on a course of study at the Royal College of Science, Walcot Gibson undertook private geological work in South Africa during 1889–91 and in East Africa during 1891–93. The rest of his active life was spent in Great Britain in the service of the Geological Survey. Appointed temporary assistant geologist in 1893, he became geologist in 1901, district geologist in 1913, and in 1920 assistant director in charge of the Survey work in Scotland. In 1925 he retired and elected to live at Hythe, where he found leisure and opportunity to indulge in his love of gardening and painting. One of his chief pleasures was to welcome his old friends and former colleagues to his new home, and none who visited him but left with an increased regard for his sanity of outlook and balanced judgment on scientific matters. Soon after the outbreak of war he had to leave Hythe, and he died in Cambridge on November 28.

Walcot Gibson was part author of numerous Geological Survey memoirs dealing with the structure, succession and economic resources of many important coalfield areas in the Midlands and in South Wales: for example, Stoke-on-Trent (1902, with second editions in 1905 and 1925), North Staffordshire (1905), South Derbyshire and Nottinghamshire (1908), North Derbyshire (1913), South Staffordshire and Warwick (1919), Abergavenny (1902), Pontypridd (1903 and 1917), and Merthyr Tydfil (1904). He had learnt from Lapworth the necessity for careful and exact mapping and the value of what his exemplar termed the "zonal method of stratigraphy". He applied these lessons with scrupulous care to his studies of the detailed stratigraphy and palæontology of the Midland coalfields, and through his published works and the many personal contacts he made in the mining world he played an important part in guiding their economic development. A notable achievement in this direction was his study of the "Concealed Coalfield of Yorkshire and Nottinghamshire" (1913).

While much the greater part of Gibson's work was of an intensive, detailed character which perhaps only the specialist can fully appreciate, he won for himself many warm admirers among a wider public by the publication in 1920 of his book on "Coal in Great Britain". In this volume he brought together in a compact and attractive form the essential information regarding the British coalfields, and its success in filling a long-felt want may be gauged by the fact that a revised and enlarged edition appeared in 1925.

Walcot Gibson's services to science, particularly in the field of economic geology, were recognized by the award in 1924 of the Murchison Medal of the Geological Society and in 1925 by his election to the fellowship of the Royal Society.

M. Macgregor.

Prof. S. G. M. Ure

PROF. S. G. M. URE, whose death at the age of sixty occurred on December 25, was widely known as one of the pioneers of chemical engineering education in Great Britain. Born in 1881, he attended Allen Glen's School and later graduated at the University of Glasgow, where he took the degrees of B.Sc. in engineering and M.A. in mathematics and physics. On leaving the university he spent five years in the shipbuilding industry before taking up the educational work to which, with one short interval, the remainder of his career was devoted.

To those who were actively concerned with the vast production programme of the War of 1914–18 the difficulties which arose through the lack of trained scientific personnel made an abiding impression. They determined that, with the return of settled conditions, a concerted effort should be made to introduce into our universities a form of training which would produce men having the qualifications necessary to ensure the development of chemical industry on sound progressive lines. The names of Lord Moulton, Sir Arthur Duckham and Prof. Hinchley will long be remembered in this connexion; and, first as assistant to Hinchley, later as his successor, Prof. Ure took a notable part in the crusade.

In 1921 Ure was appointed lecturer in chemical engineering at the Imperial College of Science and Technology and in the following year he became a founder-member of the Institution of Chemical Engineers. From then until his death his energies were devoted unsparingly to the cause of chemical engineering training and to the service of the new Institution.

In 1932 he succeeded Hinchley as assistant professor of chemical engineering in the Imperial College, and in 1937 he was closely associated with the framing of an undergraduate course in the subject.

Ure was associated with many scientific activities. He was first elected to the Council of the Institution of Chemical Engineers in 1928 and became a vice-president in 1937; he served on numerous committees of the Institution and for ten years was editor of its *Transactions*.

D. M. NEWITT.

Dr. J. S. Owens

THE death of Dr. J. S. Owens on December 6 removes a most useful and public-spirited man of science. For nearly thirty years Dr. Owens has been the moving spirit in the investigation of atmospheric pollution on its quantitative side. He devised the instruments in use, and co-ordinated, tabulated and prepared for publication all the data on which the progressive changes in the amount of pollution in the atmosphere are evaluated.

Owens was born at Enniscorthy, Co. Wexford, Ireland, on July 28, 1871. He took the M.D. degree at Trinity College, Dublin, in 1896, but soon gave up medicine for engineering. He was a successful civil engineer chiefly in connexion with sea defence works and mining, and became consulting engineer to the San Domingo Mines in Portugal, and the Rio Tinto Copper Mines in Spain.

As the result of the Smoke Abatement Exhibition in 1912 a committee was formed for the systematic investigation of atmospheric pollution, and Owens became its secretary. In 1917 the work of this committee was transferred to the Meteorological Office and Owens was appointed part-time superintendent in charge of the Atmospheric Pollution Division. In 1927 the Department of Scientific and Industrial Research took over the investigation of atmospheric pollution from the Meteorological Office, and in order that the supervision of the instruments and the compilation of statistics should remain in his charge, Owens was appointed superintendent of observations.

For the quantitative investigation of atmospheric pollution Owens devised three main instruments and several instruments of lesser importance. The most widely used of these instruments was the standard deposit gauge. This consisted of a simple collecting basin having an opening of approximately four square feet exposed in the open on a stand at a height of four feet. All the pollution and rain which fell into the basin was collected and analysed, giving valuable information as to the amount and nature of the pollution deposited from the atmosphere. The second instrument was the automatic filter gauge for determining the amount of pollution contained in a given volume of air, and the third the jet dust-counter, for counting the number of particles of soot and other insoluble particles contained in the air. All three instruments have performed invaluable service, 123 deposite gauges and 16 automatic filters being maintained by municipalities and other public bodies in 1938.

Owens's inventive skill, conscientious compilation of records and personal enthusiasm have resulted in Great Britain being far ahead of any other country in knowledge of the pollution of its atmosphere—in this he has performed a valuable public service. Three days before his death Owens was awarded the Symons Gold Medal by the Royal Meteorological Society "for distinguished work done in connexion with Meteorological Science".

Mr. R. S. Herries

ROBERT STANSFIELD HERRIES died in December last at the age of eighty-one years. He took an active part in the work of the Geological Society, of which he was secretary from 1897 until 1905, and treasurer from 1921 until 1929; and of the Palæontographical Society, of which he was treasurer from 1914 until 1938. He was president of the Geologists' Association during 1906–8, and contributed the section on East Yorkshire to "Geology in the Field" published by the Association. Herries collaborated with the late H. W. Monckton in research on the Bagshot Beds of the London Basin. His geological collection (including the one made by his brother, the late Sir W. H. Herries) was presented to the Sedgwick Museum, Cambridge, with the exception of fossils from the Yorkshire coast, which he gave to the Yorkshire Museum, York.

WE regret to announce the following deaths:

The Right Hon. the Earl of Berkeley, F.R.S., on January 15, aged seventy-six.

Dr. C. Delisle Burns, formerly Stevenson lecturer in citizenship in the University of Glasgow, on January 22, aged sixty-two.

Prof. R. S. Seton, emeritus professor of agriculture in the University of Leeds, on January 12, aged seventy-four.

NEWS and VIEWS

Science and the Classics

We had thought that the old controversy between science and the classics had been finally disposed of, but a resolution submitted on January 22 to the Lower House of Convocation of Canterbury came perilously near raising it once more. The resolution was moved by Dr. E. G. Selwyn, dean of Winchester, who urged that the revival of classical education is necessary for the good of the Church and of the nation. The classical outlook, in his view, stands for humanism, which includes the belief in absolute standards of conduct and in individual personality. Classics must, however, be made less specialized, and more room must be found for science. On the other hand, it must be recognized by science that concentration on material things imposes certain limitations. Thus in Dr. Selwyn's view, although modifications in the classical type of education are desirable, science would be admitted almost as a poor relation, presumably in deference to the needs of the times.

While no broad-minded man of science would wish to deny that an educational system based on science alone has very definite shortcomings, it is surely out of the question to suggest that any useful purpose can be served by relegating science to a subordinate position in twentieth-century studies. Science and the classics both have a place in modern culture, but should competition arise, it is to be expected that science should be given the greater share of attention. Dr. W. R. Matthews, dean of St. Paul's, discussing the resolution, emphasized that scientific studies have provided openings for many minds not naturally able to profit by classical studies, and pleaded for an all-round education including science. Eventually, the original resolution was modified and carried, with two dissentients, in the following form: "That this House, while recognizing the great value of scientific and other modern studies, is of opinion that wider recognition of the importance of classical education is urgently needed in the interests of the Church and nation and for the maintenance of a stable civilization and culture after the war."

Endeavour

Imperial Chemical Industries, Ltd., has just issued the first number of a new quarterly journal, *Endeavour*, which is designed to record the progress of the sciences in the service of mankind and as evidence of British scientific enterprise. The issue, which is priced at 5*s*., is well produced, carrying forty-eight pages of text, and well bound, with a drawing on the cover of the barque *Endeavour* which, commanded by Captain Cook, was sent out in 1768 by the British Admiralty to chart the South Pacific Ocean and observe the transit of Venus. After a brief statement by Lord McGowan of the purpose of the new journal, the number opens with a short article on "Science and the Community" by Sir William Bragg. The main feature of this initial number is Dr. H. Spencer Jones, the Astronomer Royal, on the "Distance of the Sun". Other articles are equally as authoritative, as may be judged from the following selection: Dr. C. H. Waddington, "The Epigenotype"—the author's name for the whole complex of development processes which lie between genotype and phenotype; J. G. Crowther, "Sciences in the U.S.S.R."—though the author confines himself to the physical sciences; we suggest that this be followed by one on the biological, agricultural and medical sciences, for which the world has much to thank the U.S.S.R.; A. L. Bacharach, "The Manufacture and Use of Vitamins"—in which emphasis is placed on British contributions to this important branch of science; G. V. Jacks, "Prospects for Soil Conservation"; F. Fairbrother, "The Cyclotron"; etc.

The edition of *Endeavour* before us is in English. There are to be other editions in Spanish, French and German, and a total distribution of 25,000 copies is contemplated to be sent to colleges, scientific institutions, universities and prominent individuals in foreign countries and the British Empire. The influence of the journal will therefore be much more than national, and we warmly welcome it since, as Sir James Jeans says in a communication, it "will help to make the beneficent advances of science the common property of all nations and of all races". As Lord McGowan points out, *Endeavour* will help to throw the light of science overseas especially to those parts of the globe where intimate contact with Great Britain is at present more difficult to maintain. Emphasis is laid on British scientific work, but as Lord McGowan says, the journal will not be marked by any narrow insularity, as is sufficiently guaranteed by the contents of this inaugural number. We congratulate the editor and Imperial Chemical Industries, Ltd., on this remarkably attractive and efficient achievement and wish it the success which its cause so richly deserves.

Wealden Iron Ore

It is well known, as was recently mentioned in a letter in *The Times*, that iron ore occurs in various parts of the Weald, where mining and smelting were carried on by the Romans, and were continued until the nineteenth century. Smelting ceased in 1828, and mining in 1858. The Wealden iron industry was highly decentralized, and consisted of a large number of small works. It bears no comparison with that of modern times. E. Straker, in his book "Wealden Iron" (1931), lists more than 225 furnaces, forges and bloomeries spread in time over several centuries. The life of many of these was short. The largest works were at Ashburnham; of these, Mr. Straker records that the annual output was about 350 tons. Wealden iron ore is usually a clay-ironstone and occurs in nodules and in thin beds up to a maximum of two feet in thickness, interbedded with shale. Sometimes a pale grey sideritic rock is present. The Wadhurst Clay furnished the bulk of supplies, but the other Wealden formations, and also a ferruginous superficial deposit—an ironstone 'pan' or 'shrave'—yielded their quota. Much was mined from bell-pits, which were rarely more than twenty feet deep, although some were upwards of forty feet in depth. Shale excavated with the iron ore was sold as 'marl' for agricultural purposes; indeed, agriculture and iron ore working seem to have gone hand in hand in many instances. Many quarries were opened primarily as 'marl pits', but all ironstone encountered was separated and sold when sufficient had been accumulated.

The last attempt at exploiting Wealden iron was at Snape Mine, Wadhurst, during 1857–58, ore being sent to Staffordshire. Two beds were worked, one up to two feet in thickness. Both beds were irregular in occurrence, sometimes dying out completely for a distance. The roof was bad, and required timbering. A long account of the Wealden iron industry is given by C. Gould in the Geological Survey Memoir "The Geology of the Weald" (1875), compiled by Topley, and additional information, notably an analysis of the Snape Wood ore, in the Geological Survey's "Special Reports on the Mineral Resources of Great Britain", 12 (1920). This analysis, made in 1908 for J. W. Gregory by Messrs. R. R. Tatlock and Thomson, showed the following, in percentages: FeO, 30·42; Fe_2O_3, 10·10; SiO_2, 26·10; CaO, 0·86; SO_3, 0·06. These show about 30·66 per cent of metallic iron, but the high percentage of SiO_2 would prevent the use of this stone as an iron ore. On the contrary, the Ashburnham ore showed FeO, 42·08; Fe_2CO_3, 6·85; SiO_2, 6·46; CaO, 3·87; SO_3, 0·2; giving 37·49 per cent of metallic iron, with relatively little silica. Unfortunately not only are the beds of ore thin, but they are also very irregular in their composition, and there seems little prospect that ore of this kind, which occurs in thin beds and can only be excavated together with a large amount of shale, could be profitably worked by existing methods. The usable reserves of iron ore in the Weald are, in the present circumstances, negligible.

Awards of the Geological Society of London

THE following awards of the Geological Society of London have recently been announced: *Wollaston Medal* to Prof. R. A. Daly, Sturgis Hooper professor of geology in the Museum of Comparative Geology at Harvard University, in recognition of his fundamental researches in many branches of geology, especially those concerned with the origin of igneous rocks, the constitution of the interior of the earth, and the controls of coral-reef formation; *Murchison Medal* to Prof. H. H. Swinnerton, professor of geology in University College, Nottingham, for his stimulating contributions to the philosophy of palæontology; *Lyell Medal* to Mr. W. S. Bisat, for his studies in the stratigraphical palæontology of Carboniferous rocks; *Wollaston Fund* to Dr. E. S. Hills, for his contributions to Australian palæontology and geology; *Murchison Fund* to Dr. K. C. Dunham, for his investigations into the mineral deposits of the North of England; a moiety of the *Lyell Fund* to Dr. S. R. Nockolds, for his mineralogical and petrological work and his contributions to the study of assimilation processes; a second moiety of the *Lyell Fund* to Dr. J. Shirley, for his researches in palæozoic palæontology and stratigraphy.

Institute of Metals: Platinum Medallist

THE Platinum Medal of the Institute of Metals for 1942 has been awarded to Mr. W. Murray Morrison, vice-chairman and managing director of the British Aluminium Co., in recognition of his outstanding services to the non-ferrous metals industries. Mr. Morrison is an original member and a fellow of the Institute of Metals, on the Council of which he served for sixteen years—in the last two as vice-president. He may be described as the father of the aluminium industry in Great Britain, having been associated with the British Aluminium Co. since its inception in 1894. He is also the pioneer of the developments of Highland water-power upon which depend the electro-metallurgical operations for the production of aluminium at three great Scottish factories.

Institution of Mining and Metallurgy: New President

MR. J. ALLEN HOWE has been elected president of the Institution of Mining and Metallurgy for the year 1942–43. Mr. Allen Howe was educated privately and at the Royal College of Science, and holds the London B.Sc. degree. For a year he was demonstrator in geology at the Royal College of Science and Royal School of Mines, and in 1901 was appointed to H.M. Geological Survey, where he served for thirty years on the field staff and as curator of the Museum of Practical Geology, and from 1922 onwards as assistant director. During his service he took an active part in stimulating the economic side of the Survey's work, and he is the author of several works mainly dealing with building stone, broken stone, and refractory materials. On these and other subjects he has made numerous contributions, including many articles on topographical geology and stratigraphy in the Encyclopædia Britannica (thirteenth edition). He was a member of the International Conferences on Testing Materials, and was for a number of years adviser on stone to H.M. Office of Works and since 1918 to the Imperial War Graves Commission. He was a member of the Committee on Coal Conservation and the Imperial Economic Committee. Since 1931 Mr. Allen Howe has practised as a consultant in economic geology.

Chronica Botanica

THIS international plant science news magazine, formerly published in Holland, continues to appear now from Waltham, Mass., U.S.A. Vol. 6, Nos. 17–18 appeared in November 1941 and is an exceedingly interesting number. Under the heading "Nomina ad Infinitum" Dr. F. C. Bawden asks for a more vigorous effort to rationalize procedure in the naming of virus diseases of plants, and then in the "Plant Science Forum" a number of subjects of general botanical interest are raised by well-qualified contributors. Very general interest will be aroused by a brief note from Dr. W. C. Darrah on the fossil embryos in Iowa coal balls; in particular, in the record of the discovery of the embryo and young seedling of a Lepidocarpon. There then follows a series of brief "Progress Reports" on plant science in Latin America, for example, on forestry in Mexico (Meyer), natural resources of Costa Rica (Skutch), etc.

International activities naturally do not bulk largely in the present day, but there is a note on the International Forestry Centre, which, established in May 1939 as a division of the International Institute of Agriculture, held its third meeting in March 1940 in Berne. The "Chronicle" of events has a very full statement of Kew activities in view of the centenary of the Royal Botanic Gardens in 1941: there is an interesting account also of the All-Union Agricultural Fair held in Moscow during 1939 and 1940 and again re-opened in the early summer of 1941. Details of the activities and vicissitudes of various botanical departments under present disturbed conditions make interesting reading to botanists, and similarly the many changes in personnel chronicled will often bring news of colleagues to readers. Very naturally the editors have contemplated closing this venture with the completion of vol. 6, and the extension of the War to the Pacific will possibly force them to reconsider their present decision to proceed at least with the issue of Vol. 7 in the form of twelve numbers to be issued once every three months. If publication can be continued, however, this chronicle is probably more valuable to the botanical world under present conditions than even in normal times.

Rapid Glass-house Repair

THE problem of repairing small holes in glass-houses both rapidly and economically has confronted many growers since the outbreak of war. After a thorough investigation of the matter, the Cheshunt Experimental and Research Station recommends the use of Bostik B. glazing compound, manufactured by the B. B. Chemical Co., Ltd., Ulverscroft Works, Leicester. The glass must be clean and perfectly dry. An extending nozzle is fitted to the Bostik tube, by means of which a thick flat continuous bead of the compound is delivered. This is allowed to dry for five or six minutes. The piece of glass which is to serve as a patch is then pressed lightly down on to the bead and a further film of Bostik applied around the outer edge of the patch to complete the seal. Glass substitutes can be used for patching instead of glass, and cracks can be satisfactorily sealed by a bead of the compound. All particulars are given in War-Time Notes No. 1, issued with the annual report of the Cheshunt Research Station for 1940.

Health of Eire

ACCORDING to the report of the Department of Local Government of Eire for 1939–40, 1939, as in all parts of the world from which statistics are available, was a record year in Eire owing to the low prevalence and fatality of acute infectious diseases. There were only 2,779 notifications of scarlet fever with 43 deaths in 1939, both figures being much the lowest on record. There were 2,097 cases of diphtheria with 245 deaths which accounted for nearly two thirds of all deaths from endemic infections. The fatality rate of diphtheria, as in all parts of the world, unlike that of measles, whooping-cough, and scarlet fever, showed no tendency to fall. There was an apparent increase in the mortality from tuberculosis, but this was probably accounted for by an improvement in notification.

Vital Statistics of Switzerland

RECENT statistics show that the decline in the birth-rate in Switzerland still continues. In 1939 it exceeded the death-rate by only 3·4 per thousand inhabitants as compared with 3·6 in 1938, 4·2 in 1936, 5·6 in 1930, 6·5 in 1920, 9·9 in 1910 and 11·5 in 1903. The death-rate reached its lowest record in 1934 and in 1937 with 11·3, but rose to 11·6 in 1938 and 11·8 in 1939. Since 1871, with few exceptions, the marriage-rate has fluctuated between 6·8 and 7·9, and the marriage age of single men has risen from 28·5 to 28·9, and of single women from 26·1 to 26·7.

Mechanism of the Sun

THE presidential address to the British Astronomical Association was delivered on October 29 by F. J. Sellers, and dealt with the sun. Mr. Sellers is director of the Section of the Association dealing with the sun, and has done a considerable amount of research along certain lines. He has designed a very useful form of spectroscope and also a form of vibrating slit mechanism for the spectro-helioscope, and is a keen observer of solar phenomena. His address covered a very extensive field; here it is sufficient to say that the most up-to-date information on nuclear reactions in the interior of the sun, sunspots, the corona, chromospheric eruptions, etc., was discussed. The address is printed in full in the *Journal of the British Astronomical Association* (52, 1; 1941).

The Night Sky in February

THE moon is full on February 1d. 9h. 12m. and new on February 15d. 10h. 2m. U.T. Lunar conjunctions with the planets occur on the following dates: Venus on February 14d. 0h., Venus 5° N.; Mars on February 22d. 1h., Mars 6° N.; Saturn on February 22d. 3h., Saturn 3° N.; Jupiter on February 23d. 19h., Jupiter 5° N. Mercury is an evening star until February 8, then a morning star. Venus is a morning star, and Mars, Jupiter and Saturn are evening stars. On February 24d. 2h. Mars is in conjunction with Saturn, Mars being 3·5° N. Mars, Jupiter and Saturn are still well placed for observation during the month. The planet Uranus, seen as a 6th magnitude star, is in the western part of Taurus and about 5° south of the Pleiades. In the latitude of London the day lengthens by about 1¾ hours during the month.

Announcements

DR. SELIG HECHT, professor of biophysics at Columbia University, has been awarded the Frederic Ives Medal of the Optical Society of America for "distinguished work in the field of optics".

THE Pan-American League for the Control of Cancer will meet this year at Buenos Aires under the presidency of Prof. H. Angel Roffo.

THE International Commission on Continental and Oceanic Structure of the International Union of Geodesy and Geophysics (chairman, Dr. R. M. Field) has found means to continue in operation the Scoresbysund seismological station, originally run in connexion with Danish stations. Funds were granted by the American Philosophical Society of Philadelphia, which will supply paper and other photographic materials for another year of operation. The supplies have been shipped.

THE Rugby Branch of the Association of Scientific Workers is conducting a series of lectures and meetings, held on Thursdays, on the general theme, "The Coming Post-War World". Among the speakers are Prof. V. H. Mottram on the social implications of dietetics, Capt. J. Langdon Davies on scientific invention at the service of the community, and Prof. A. St. G. Huggett on the social basis of physical and psychological health. Particulars can be obtained from the honorary secretary, J. B. Laurie, Upper Rainsbrook, Ashlawn Road, Rugby.

THE Clough Memorial Research Fund was instituted in 1935 for the purpose of encouraging geological research in Scotland and the North of England. The North of England is defined as comprising the counties of Northumberland, Cumberland, Durham, Westmorland and Yorkshire. Under the terms of administration of the fund a sum of approximately £30 is available annually. Applications for grants are invited for the period April 1, 1942—March 31, 1943, and should be made to the Secretary, Clough Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh, not later than March 1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Uplift in Dams

In the design of masonry or concrete dams, the uplift due to the penetration of water into the structure is a factor which up to the present has not been completely investigated. Previous experiments intended to solve the problem gave rise to much controversy as to the interpretation of the results[1].

In the following experiments, which were made for the Projects Department of the Ministry of Public Works, Egypt, results have been obtained which are independent of theories about the internal structure of the material.

The apparatus consists of a test chamber in which a cylindrical test-piece of concrete of length 60 cm. and diameter 15 cm. is placed in such a manner that one of its extremities projects beyond the container. The test chamber is connected to a water supply the pressure of which can be raised by an accumulator, and this water pressure is applied to the middle part of the outer surface of the test-piece. At the same time the test-piece can be subjected to an axial compression or tension by means of a system of levers and weights. This force varied from 5 tons compression to 2 tons tension. The test-piece has a hole of 4 cm. diameter along its axis to allow air to escape from the pores, but more important, to make certain that the external water pressure is acting right through the specimen when failure occurs. In making an experiment, the longitudinal force N is first applied, and then the pressure of the external water is raised to a pressure P and maintained constant while water percolates through the specimen and produces a pressure Q in the axial cavity. The external pressure is raised by slow steps, depending on the rate of rise of Q, until fracture takes place. The whole experiment takes from three to five days to complete.

To understand the principle of the experiment we imagine the simple case where a solid cylinder, the area of cross-sections of which is S, is compressed by a longitudinal force N and finally broken after a long time by the external water penetrating the material under pressure P. The pressure P, owing to the porosity of the substance, acts over a fraction f of the cross-section: let the resistance of the material just before breaking takes place be z. Then we have

$$PfS = z + N,$$

where we do not know either f or z.

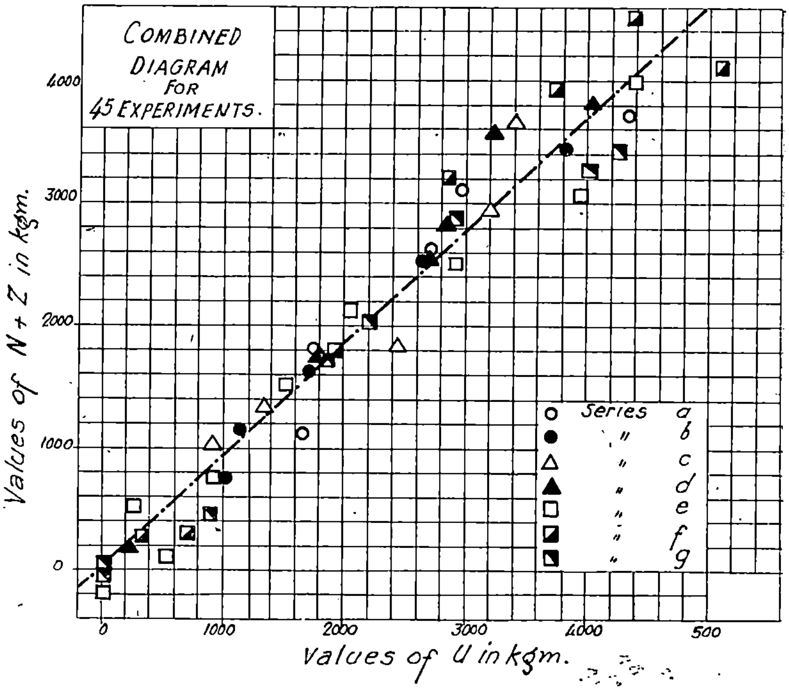
By making a number of experiments with different values of N, we obtain a series of equations from which we can determine f and z.

In the experiments, the pressure p in the interior of the test-piece varies from P outside to Q inside, the two being not necessarily equal. PS is therefore replaced by $\int p dS = U$, the value of which is:

$$U = QS + (P - Q)S\left[\frac{D^2}{D^2 - d^2} - \frac{1}{2\log D/d}\right].$$

While this formula was developed from the elementary theory of laminar flow, it was also verified empirically and found fairly accurate both in regard to the experiments under review and other experimental investigations[2].

For determining the coefficient f, some six or ten test-pieces are made of the same material and these are broken each with a different external load N. The values of U are then calculated and plotted against N. Allowing for the unavoidable variation of the test-pieces, the relation between U and N is found to be linear. The coefficient f is therefore given by the slope of the line expressing this relation. Contrary to what might have been expected, f was not very much affected by the materials or methods used in making the specimen, and only varied from 0·85 to 0·98, with a mean value of 0·92. In consequence of this, it has been possible to plot the results of the forty-five tests made up to the moment on a single diagram.



The materials used and the individual coefficients found were:

Series	Proportion of cement to sand and to coarse aggregate (volumes of dry materials)	Type of sand	Type of coarse aggregate	Water-cement ratio	f
a	1·0—1·6—1·1	Average	Crushed Granite	0·40	0·88
b	1·0—2·7—3·3	,,		0·93	0·92
c	1·0—1·1—2·2	,,	,,	0·50	0·95
d	1·0—2·3—4·2	,,	,,	0·72	0·99
e	1·0—1·7—4·6	Coarse	,,	0·58	0·87
f	1·0—1·1—2·2	,,	Gravel	0·40	0·96
g	1·0—2·8—0·0	,,	—	0·44	0·85

The probable deviation of a point from the mean line is about ± 200 kgm., while the probable error of f is only $\pm 0{\cdot}02$.

The observations were examined statistically for systematic effects due to varying ages of the specimens, or to changes of the tensile resistance Z due to compressive ring stresses at right angles to the main axis, or to variation of the superimposed load N. No effects of this nature were found.

The porosity of some specimens was determined by weighing and drying, and was always less than 20 per cent. The fraction of the area of cross-section over which the internal pressure acts can therefore have nothing to do with ordinary porosity, and the results of the experiments tend to support Prof. Terzaghi's views. They may lead to changes in the methods of allowing for uplift in the design of dams.

Further work is going on, and it is intended later to publish a full account of the work in an Egyptian Government publication.

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[1] *Mitt. a. d. mech.-techn. Lab. d. k. Techn. Hochsch. München*, **27**, 1 (1900).

[2] Rudeloff and Panzerbieter, "Versuche über den Porendruck des Wassers im Mauerwerk" (Berlin, 1912).

[3] Fillunger, "Versuche über die Zugfestigkeit bei allseitigem Wasserdruck", *Oesterr. Woch. f. d. öff. Baudienst*, **29** (1915).

[4] Hoffman, "Permeazioni d'aqua e loro effeti nei muri di ritenuta" (Milan, 1928).

[5] Terzaghi, "Die wirksame Flächenporosität des Betons", *Z. öst. I. und A. Vereines*, Heft 3/4, p. 1, Heft 5/6, p. 30, Heft 7/8, p. 45 (1934).

[6] Fillunger, "Nochmals der Auftrieb in Talsperren" and "Die wirksame Flächenporosität Prof. Terzaghi's", *Z. öst. I. und. A. Vereines*, 5/6, 28, and 7/8, 44 (1934).

[7] Terzaghi, "Simple Tests Determine Hydrostatic Uplift", *Eng. News-Record*, p. 872 (June 18, 1936).

Surnames and Blood Groups, with a Note on a Probable Remarkable Difference between North and South Wales

Two years ago[1] Prof. R. A. Fisher and Dr. Janet Vaughan suggested that recent population movements in Great Britain can lead to significant association between surnames and blood groups. They found that out of 11,377 donors resident in the Slough area 591 bearing Welsh family names were significantly lower than the remainder in the frequency of A. Counts of blood groups donors now in progress have yielded striking proof of the value of this simple technique; and incidentally have revealed a startling and (to me) unexpected difference between North and South Wales.

Taylor, Race and Fisher[2] have given figures which illustrate the great variability in the frequency of A in the British Isles: Southern England, $O = 45$ per cent, $A = 43$ per cent; Northern England, $O = 48$, $A = 40$; Scotland, $O = 52$, $A = 34$. Haldane[3] gives the following figures for an Irish sample: $O = 56$, $A = 30$. These figures will serve as a standard of comparison for those given in the present communication.

A sample of 2,550 Welsh donors, drawn from Caernarvonshire, Denbighshire and Flintshire, gives: $O = 48$ per cent, $A = 40$ per cent. When, however, the sample is divided into 1,132 donors with Welsh family names and 1,418 donors with non-Welsh family names, the Welsh donors give $O = 51$, $A = 36$: the non-Welsh donors give $O = 45$, $A = 43$. The difference is highly significant. (The high proportion of non-Welsh names in the sample is largely due to the North Welsh coastal area being strongly represented.) Here, then, the family name technique has unmasked the diluting effect of recent migration and has revealed an important difference in blood groups between two partially isolated populations inhabiting the same area.

Another positive result was found when donors with Highland Scottish and Irish names living in the Bristol area were compared with the remainder. 40,740 donors in this area have given $O = 44$, $A = 44$. 778 donors with characteristically Highland or Irish names have given $O = 49$, $A = 38$, again a highly significant difference.

During the course of this work it became apparent that North and South Wales were strangely different. The first piece of evidence was that 3,242 donors with Welsh names drawn from the Bristol sample were as high in A as the remainder. Yet much of this immigration must be very recent, for the proportion of men was considerably higher among the Welsh donors. As Welsh names in Bristol must be overwhelmingly of South Welsh origin, the North Welsh material was re-examined, the Welsh names being classified according to their relative frequencies in North and South. I relied on Guppy's "The Homes of Family Names"[4] in making the selection. It was found that donors with names more characteristic of South Wales were significantly higher in A. Prof. Fisher has very kindly provided some figures relating to South Wales. 1,765 Cardiff donors give $O = 45$, $A = 43$; 537 Swansea donors give $O = 45$, $A = 40$.

Further work is in progress, but even on the evidence now available it seems probable that while the North Welsh are, as regards blood groups, kin to the Highland Scots and the Irish, the Southern Welsh are almost indistinguishable from the Southern English. Surnames came into common use in Wales during Tudor times, so it appears likely that the peoples of the North and South who at that time adopted the same family names were already very different; after all, perhaps, not such a surprising result in view of the different influences known to have affected the two parts of the country and the great difficulties of communication between them.

Fisher and Vaughan[1] have undoubtedly directed attention to a simple and valuable technique, and it is much to be hoped that blood group investigators will avail themselves of it in connexion with appropriate material. The additional clarification thus made possible may often be considerable. The usefulness of the method is not, of course, confined to blood group studies.

When these investigations are complete it is intended to report them fully in the *Annals of Eugenics*. I will then take the opportunity of expressing my great indebtedness to all those who have so kindly provided the facilities which have made the work possible.

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Jan. 2.

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[1] NATURE, **144**, 1047 (1939).

[2] *Brit. Med. J.*, **1**, 315 (1941).

[3] *Human Biology*, **12**, 457 (1940).

[4] London, Harrison and Son (1890).

Vernalization of Mustard

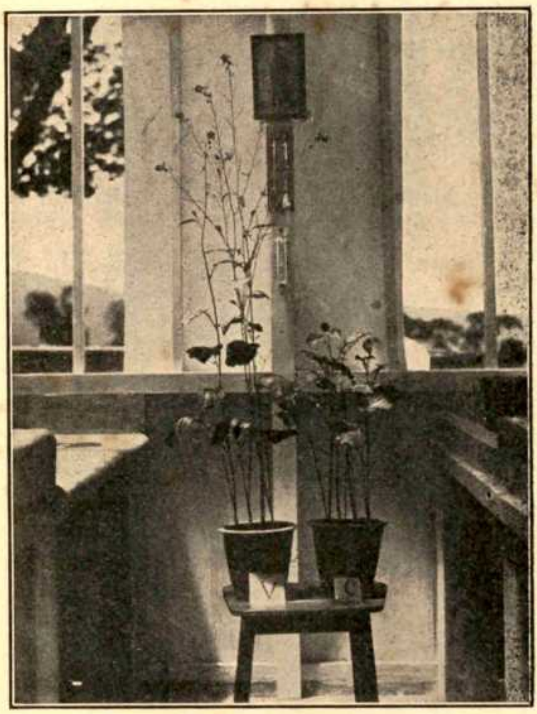
In our preliminary report[1] on vernalization of mustard (*Brassica juncea*, Hooker Type 27) it was shown that even seeds previously soaked which remain unsplit during the period of chilling are vernalized. Though the degree of vernalization induced by the same dose of chilling is greater in seeds which sprout during the period, only unsplit chilled seeds offer practical agricultural possibilities, since the latter can be dried without impairment of subsequent germinating capacity. Four other strains of Indian mustard—Types *C*.9, *C*.11, Raya *O.B*.1, and yellow sarson—have all since been found to respond to vernalization. For the same dose of chilling, the shortening of the vegetative period (from sowing to opening of the first flower) of plants from unsplit chilled seeds have been found to vary according to the strain.

Most of our vernalization experiments with mustard have been carried out with Type 27, in which maximum vernalization is induced in unsplit seeds when chilled for six weeks. Further prolongation of chilling up to 365 days does not induce any higher degree of vernalization, nor any devernalization.

Lojkin[2] found that vernalized seeds of winter wheat when air-dried at 1° C. and 15° C. were partially or completely devernalized, and Gregory and Purvis[3] observed complete devernalization when fully vernalized seeds of winter rye were dried for twenty weeks. Drying vernalized unsplit mustard seeds, however, is surprisingly without effect. For it has been found from a long series of sowings, spread over a period of two years, of the same batch of dried vernalized unsplit seeds, that the vegetative periods of *V*-plants sown on similar dates in two successive years (subjected to more or less the same after-sowing temperature ranges and photo-periods) remained strikingly constant. Thus, in the first sowing (April 24, 1939) when the *V*-seeds had been dried for twenty-one days only, the observed vegetative period was 31·9 ± 0·54 days (mean of eight plants), and in the ninth sowing, April 24, 1940, when the period of drying was 387 days, the vegetative period observed was 30·5 ± 0·41 days (mean of 15 plants). Similarly, in the eighth sowing, March 20, 1940, and the twentieth sowing, March 28, 1941, the respective periods of drying were 352 and 725 days, and the vegetative periods of *V*-plants were 37·5 ± 1·48 days (mean of 4 plants) and 34·9 ± 0·57 days (mean of eight plants). These results indicate that drying of vernalized unsplit seeds of mustard for a period of 725 days did not induce any devernalization. In the case of vernalized intact fruits of winter rye also, which Gregory and Purvis[2] obtained by chilling the embryo in the ear during seed formation, drying did not induce devernalization. Thus it would appear that when the growth of the embryo is confined within the elastic limit of the seed-coat, chilled seeds can be dried without resultant devernalization.

Results of seasonal sowing (October 1939) of fully vernalized unsplit seeds of mustard along with the controls in replicated field plots show that under the climatic conditions of Almora a significant earliness in flowering of 25·4 days (31·3 per cent) in Type 27, 20·3 days (23·8 per cent) in *C*.11, and 29·57 days (31·3 per cent) in *C*.9 can be obtained by the use of vernalized unsplit seeds.

The observed vegetative periods of *C*- and *V*-plants (Type 27) grown throughout the year under different seasonal temperature ranges but under similar effective photo-periods indicate that: (1) Mustard Type 27 has no obligatory low-temperature requirement for the *first phase* of development, for plants from untreated control seeds flowered when the minimum night temperature was 20° C. or higher. On the other hand, under all different after-sowing temperature ranges studied (max. day temperature 44°–10° C. and minimum night temperature 22°–1° C.) and of photo-periods (10–16 hr.), plants from fully vernalized unsplit seeds flowered significantly earlier; (ii) Mustard Type 27 flowers under photo-period of 10 hr. as well as 16 hr.; but under all temperature ranges studied both *C*- and *V*-plants flower significantly earlier with increase of photo-period from 10 hr. to 13 hr. for the initial three weeks; (iii) within limits, the effect of low temperature during the *first phase* of development and of increased photo-period during the *second phase* in shortening the vegetative period of mustard is of a *quantitative* nature. Under similar temperature ranges *V*-plants under photo-period of 10 hr. and *C*-plants under photo-period of 13 hr. or more have been found to have similar vegetative periods. The original concepts of Lysenko's theory of phasic development of annual seed crops[4] therefore do not seem to apply to Mustard Type 27, either with regard to the obligatory nature of changes produced by low temperature during the *first phase* or the strict dependence of each phase on the completion of the preceding one.



MUSTARD TYPE 27. PLANTS IN POT *V* ARE FROM VERNALIZED UNSPLIT SEEDS CHILLED SIX WEEKS, DRIED SIX DAYS: IN POT *C* ARE PLANTS FROM CONTROL, UNTREATED SEEDS. BOTH SOWN ON JULY 11, 1938.

The observed vegetative periods of plants from the progeny of seeds vernalized for three successive generations of Mustard Type 27 do not indicate any transmission of the effect of vernalization to the offspring. But low temperature during the period of seed ripening has been found to produce partially vernalized seeds.

A detailed report of this work is being published in a forthcoming number of the *Indian Journal of Agricultural Science*. Expenses of the investigation have been met by grants from the Elmgrant Trust of Dartington, Totnes, and the Imperial Council of Agricultural Research, New Delhi.

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Nov. 3.

[1] Sen, B., and Chakravarti, S. C., *Ind. J. Agric. Sci.*, **8**, 245 (1938).

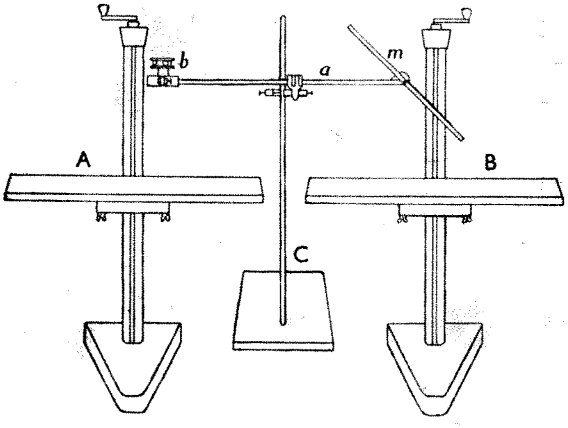
[2] Lojkin, M., *Contr. Boyce Thompson Inst.*, **8**, 237 (1936).

[3] Gregory, F. G., and Purvis, O. N., *Ann. Bot.*, N.S., **2**, 237 (1938).

[4] Bulletin 17, Imperial Bureau of Plant Genetics (1935).

Use of the Camera Lucida for Transcribing Diagrams

INTERESTING modifications of the camera lucida for making larger drawings were recently described in these columns[1]. A novel use to which I have put this apparatus may also assist biologists in their work. Teachers and research workers in biology who regularly abstract information from the original literature must have felt the need for obtaining accurate copies of diagrams and figures which accompany the text of publications. Various methods of transcription are known; but apart from tracings, which leave much to be desired, they call for apparatus which is rarely available. The following method of using an ordinary camera lucida of the Abbe type for transcribing diagrams has the advantage of permitting enlargement or reduction of the original.



Two small drawing boards are provided on their lower surfaces each with a U-shaped support of ⅜ in. iron rod having two projecting lugs which will fit into the clamps of a pillar stand such as is used in physiological experiments. The stands to which the boards have been clamped are placed to the left and the right (*A* and *B* in accompanying figure) of an ordinary retort stand (*C*) the clamp of which grips the arm (*a*) of the camera lucida so that the prism and light filters (*b*) of the apparatus overhang the left board (*A*) while the mirror (*m*) overhangs the right board (*B*). The distance apart of the pillar stands is determined by the length of the arm (*a*), the vertical level of which is in turn determined by the work in hand. Each board can be raised or lowered separately by rackwork through a vertical distance of approximately eighteen inches.

The figure which is to be copied is placed upon board *A* and covered with a sheet of plate-glass, and the paper on which the copy is to be made is pinned in position upon board *B*. The drawing is made exactly as if the camera lucida were being used for microscopic work, that is, the object is viewed through the perforated prism at *b* (as is the image of a microscopic object) and is seen in relation to the image of the paper which is superimposed upon it as a result of light reflexion from the mirror and the prism.

When the boards *A* and *B* are set at the same horizontal level the copy will be enlarged (my apparatus gives a ratio of approximately 4/3), but by setting the boards at different levels various amounts of reduction or enlargement can be achieved. The lowering of board *A* and the raising of board *B* favour reduction and vice versa. With ordinary equipment I obtained at the two extremes a reduction by one half and an enlargement of five diameters respectively. The methods advocated by Harding for enlarging drawings may be used to increase this range.

The ordinary light screens with which the camera lucida is provided also serve when the apparatus is used for the transcription of diagrams, but modification of the lighting arrangements to suit individual needs is advantageous. Manipulation of bench lamps will remove any lighting difficulties.

The alternate focusing of the eye on the diagram and the copy may involve strain, especially when the apparatus is being used for reduction or enlargement. This can be avoided by placing a biconvex spectacle lens above the prism of the camera lucida. When preparing enlarged or reduced copies of the original diagram, I use lenses of 13 in., 18 in. and 20 in. focal length, with the alleviation of eye strain and with greater ease of working.

Some difficulty might be experienced when the figures which are to be copied occur in large volumes or manuscripts. This can be overcome by the use of a sliding mirror (*m*) on an appropriately lengthened arm (*a*).

This arrangement of ordinary laboratory equipment may be used for preparing graphical records of published diagrams in original papers and for accurate diagrammatization of complex figures for teaching purposes. I have used it for transcribing unequal original diagrams of related Trematoda to the same size in the copy[2]. This means of cancelling out absolute size differences revealed *relative* differences which are of some taxonomic importance, but which were obscure in the originals.

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[1] Harding, NATURE, **148**, 754 (1941).

[2] Dawes, *Parasitology*, 1942 (in the press).

RESEARCH ITEMS

The European Earwig in America

In Technical Bulletin 766 (1941) issued by the U.S. Department of Agriculture a very full account is given of this insect and of methods for its control. The authors, S. E. Crumb, P. M. Eide and A. E. Bonn, describe in the first place its distribution, where it occurs on both the eastern and western sides of North America. It appears to have been first noticed in Rhode Island, in the west, in 1911 and, in the east, at Seattle in 1907. It has also become established in British Columbia, where it was first noted in 1919. The survival and abundance of the insect are dependent mainly on the amount of desiccation to which it is subjected, it being best adapted to cool latitudes. It is omnivorous, but prefers the lower plants (algæ, lichens, etc.) to most of the higher types of vegetation. The eggs are deposited in cells in the soil in January and February and the adults begin to appear in July. A proportion of the females re-enter the soil in about May and deposit a second batch of eggs. The female watches over the eggs and first instar nymphs and will fight savagely in their protection. The earwig rarely flies, but the authors state that they have noticed as many as twenty flights in one day. Although so pronouncedly nocturnal in many of its habits, it seems to fly mostly in bright warm sunshine. It is considered that the best method of repressing this insect is by means of poisoned baits. The one found most successful on a large scale consists of a mixture of wheat bran, twelve parts by weight and one part each of sodium fluosilicate, and fish oil.

Beetles of the Family Lathridiidæ

Dr. H. E. Hinton of the Department of Entomology, British Museum (Nat. Hist.), has contributed an article (*Bull. Ent. Res.*, November, pp. 191–247) on Lathridiid beetles of economic importance. Altogether about thirty species of this family have been recorded among stored food products or have occurred in warehouses, granaries or mills. Among these, ten species have not hitherto been recorded from Britain. Under each species are given summaries of its distribution, life-history and the literature relating thereto. Also, for the first time, complete life-histories of five species have been worked out, and the larval and pupal stages are carefully figured. The family as a whole comprises about 520 species, all small (1–3 mm. long) and they, together with their larvæ, are found in mouldy plant and animal substances, in mycetozoa and fungi, in vegetable detritus, under bark and stones and sometimes in ant and termite nests. Both stages apparently only feed on mycetozoa and fungi, particularly moulds. It appears that none of the species dealt with is responsible for any direct injury to food, since they are exclusively fungus feeders. When present in considerable numbers, they may cause a certain amount of damage by fouling food substances with their fæces. Since they are able to transmit moulds to uncontaminated foods, they may in this way entail losses. Control measures comprise drying, heating, or fumigation. Any measures that will eliminate fungi will also be effective in getting rid of Lathridiid beetles.

Somatoplastic Sterility

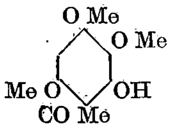
R. A. Brink and D. C. Cooper (*Genetics*, 26, 487–505; 1941) have studied the development of seeds in the cross *Nicotiana rustica* × *N. tabacum*, which rarely produces viable seeds, and in *N. rustica* × *N. glutinosa*, in which no viable seed is produced. They find that endosperm growth is retarded, hyperplasia of the nucellus occurs, and the cells of the integument between the apex of the vascular bundle and the chalazal pocket do not differentiate into conducting tissue. Where the endosperm and the embryo do grow in the first cross, it is found that they grow at the expense of the neighbouring integumental cells, which are thereby depleted of their contents. The authors consider that this somatoplastic sterility is of widespread occurrence in economic plants such as apples, pears, or seedless fruits, and is of great importance in regard to such phenomena as June-drop, poor cropping and varietal differences in fertility.

Chromosome Homologies in the Genus Drosophila

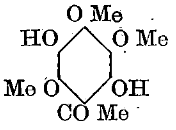
The result of the intensive experimental work of the last twenty years is bearing fruit in providing an insight into the genetical composition of the chromosomes of the various species of Drosophila. In an important paper, A. H. Sturtevant and F. Novitski (*Genetics*, 26, 506–517; 1941) have summarized the facts from more than thirteen species of Drosophila. Taking the arm from the centromere to the end of the chromosome as the unit or element, it is shown that the six arms of the chromosomes of *D. melanogaster* retain their genetical identity in the remaining species. Within each element the sequence of the genes is dissimilar between the species, and it is shown that the different sequences of the genes in *D. melanogaster* and *D. pseudo-obscura* are not more alike than would result from chance. Few or no translocations have become established in these two sub-genera. A change in chromosome number would appear to occur by a special type of translocation within the heterochromatin area near the centromeres. This would more likely decrease chromosome number; hence *D. virilis*, in which the six elements are separate, is taken as the most primitive. The higher Diptera have six chromosomes. Whether these are identical with the Drosophila elements is unknown, but the integrity of the elements must break down in the more distantly related Diptera species.

Derivatives of Pentahydroxybenzene

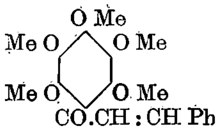
There has been an increasing interest in naturally occurring derivatives of pentahydroxybenzene, and these (calycopterin or thapsin, nobiletin, spinulosin, erianthin and pedicin and closely related compounds) are mentioned by W. Baker (*J. Chem. Soc.*, 662; 1941), who reviews recorded syntheses of pentahydroxybenzene derivatives and describes some very simple syntheses starting from pyrogallol, as a result of which, for the first time, some of these substances may now be very readily prepared. The pyrogallol was converted into 1 : 2 : 3 : 5-tetramethoxybenzene from which pentamethoxybenzene can be prepared by way of two intermediates. The synthetic methods make use in the final stage of the oxidation of *o*-hydroxytrimethoxyacetophenones by alkaline hydrogen peroxide to give dihydroxytrimethoxybenzenes. The catechol derivative is oxidized by aqueous ferric chloride to the quinone, various derivatives of which are described. The compound is oxidized by alkaline potassium persulphate to the pentahydroxyacetophenone derivative (II), from which the naturally occurring chalkone pedicellin (III) is synthesized. Pentamethoxybenzene, by the action of acetyl and aluminium chlorides in ether, gives hydroxypentamethoxy acetophenone, from which (see NATURE, Jan. 10, p. 52) hexamethoxybenzene can readily be obtained.



(I)

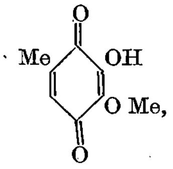


(II)



(III)

A synthesis of the mould metabolic product fumigatin, 3-hydroxy-4-methoxy-2 : 5-toluquinone,



a derivative of tetrahydroxybenzene, is also described by W. Baker and H. Raistrick (*J. Chem. Soc.*, 670; 1941).

Preparation of Deuterium Compounds

SOME experiments on the preparation of tetradeuteroethylene $D_2C : CD_2$ are described by C. L. Wilson and A. W. Wylie (*J. Chem. Soc.*, 598; 1941). This substance has been prepared before, for example, by introducing deuterium into the ethylene molecule by exchange in presence of a nickel or platinum catalyst and by the combination of deuteroacetylene and deuterium bromide under the influence of ultraviolet light, followed by the removal of bromine from the resulting dibromoethanes by zinc. The present authors find that a mixture of isomeric dibromotetradeuteroethanes containing about 10 per cent of ethylidene dibromide is formed by passing deuterium bromide (an apparatus for preparing which from bromine and electrolytic deuterium is described) and dideuteroacetylene over a prepared charcoal catalyst at 180°. The best sample contained 99·7 atom per cent of deuterium. The isotopic analysis was made by burning a mixture of the sample with highly purified ordinary ethylene dibromide by passing in a stream of dry air over red-hot copper oxide, purifying the combustion water, determining its density, and calculating the deuterium content by a formula. The reaction with zinc of the mixed deuterobromides in solution in purified dioxane to which one drop of deuterium oxide had been added was the method used for the preparation of tetradeuteroethylene, by reaction of which with bromine pure tetradeuteroethylene dibromide was obtained.

Comet Positions by Cross-bar Micrometer

W. T. HAY has described his home-made micrometer specially used for the determination of comet positions (*J. Brit. Astro. Assoc.*, 52, 1; 1941). The cross-bar micrometer consists of two metal wires (in the present case 10-amp. tinned copper fuse wire) set at an angle of 90° to one another and crossing in the middle of the field. A third wire bisects two of the right angles thus formed, and it is used for setting the micrometer in its correct position; this is attained by setting the third wire parallel to the celestial equator, so that a star will move along it when the telescope is moved in right ascension. When a comet and a star have been located in the same field, the driving clock of the telescope is stopped, allowing the two objects, which should be north and south of the field, to drift across the field of view. The difference between the mean of the times when the star crosses the wires, say, north of the field, and when the comet crosses the other two wires on the south of the field, gives the difference in right ascension in mean time seconds, which is then reduced to sidereal seconds. Half the sum of the times required by each object to cross its wires, reduced to sidereal seconds, multiplied by 15 times the cosine of the declination, gives the difference of declination in seconds of arc. In a separate paper Hay gives the results of nine observations of Comet van Gent, and from these Davidson and Sumner computed an orbit (see NATURE, **148**, 562; 1941) which is slightly hyperbolic.

Leander McCormick Proper Motions

A. ALI has published (*Mon. Not. Roy. Astro. Soc.*, **101**, 7; 1941) the result of the preliminary work done in connexion with the study of proper motions of the faint stars in the *Publications of the Leander McCormick Observatory*, 5, 11 (1937), on the basis of the two-streams theory. Three groups, which included about 2,100 stars, were selected sufficiently far apart from each other to give a fair idea of the preferential motions. As the form of the frequency curve was found to be very sensitive with regard to the position of the absolute origin in each region, three "absolute" origins were employed in each region, their respective frequency curves being obtained. A description is given of the method for determining the three absolute origins, and three figures show the frequency curves for Group 21 and Regions 276 and 295 included in it. The frequency curves, generally speaking, are distorted by considerable irregularities, and it is difficult to analyse them by Eddington's 'trial and error' method. Indeed, the absolute origin is indeterminate, indicating the presence of systematic or relatively large accidental errors, and it is suggested that a systematic error may exist in all the galactic regions in the McCormick memoir.

Interstellar Lines in the Laboratory

THREE sharp interstellar lines at 4232·6, 3957·7 and 3745·3 A., which had not hitherto been identified, have been reproduced by A. E. Douglas and G. Herzberg (*Astrophys. J.*, 94, 381; 1941) in a discharge through helium containing a trace of benzene vapour. They are the $R(0)$ lines of three bands, with heads at 4225·3, 3954·0 and 3743·4 A. respectively, each of which consists of three singlet branches corresponding to a $^1\Pi - {}^1\Sigma$ transition. The laboratory and interstellar wave-lengths are in agreement to 0·03 A. The only lines of these bands which would be expected in interstellar space are those coming from the lowest rotational level of the lower state, which are just the ones observed. Since the molecule BH has a $^1\Pi - {}^1\Sigma$ system with a (0,0) band in this region, and since the rotational constant in the lower state of the new bands is close to that for CH, the isoelectronic CH^+ is suggested as the emitter. This suggestion is strengthened by the fact that the other neutral and singly ionized hydrides of the second period of the periodic system are all well known except for three, which in any case cannot have singlet bands. The presence of CH^+ in interstellar space, as well as the neutral molecule CH discovered some months ago, seems thus to be established.

AN EXPERIMENT IN SOCIAL SCIENCE

THERE is a growing appreciation of the problem of the relation between management and labour : it is one which bristles with difficulties, in part because there is a lack of understanding on both sides and often, indeed, unwillingness to try to understand. As labour grows more and more independent, partly because of its political power, it becomes more necessary than ever to seek any and every means to promote such understanding, so that a factory can be run for the common weal, to give continuous remunerative employment to all connected with it, to give a fair return on the money invested in it, having regard to the risk, to set aside sufficient for depreciation and development so that the business may last for generations and not collapse exhausted in a few years like the wheat fields of the West after half a dozen crops.

If these prime essentials are agreed, then every worker, high or low, must actually earn, that is, produce goods of a value greater than his pay ; if he fail to do this, then he is a drag on the concern and must be removed or it will fail. The usual stupid remedy for bad times is to reduce wages ; a more scientific solution would be to increase the amount of work and cheapen the product, thereby making it more competitive and easier to sell. Unfortunately, the economics of bad and good times are more complex than the above simple basic principles, but none the less they are still largely applicable in most factories.

It is the task of management to see that every worker is able to earn more than his pay by adequate production, also that quality is maintained, research and development fostered, plant and machinery kept in order. Over and above this, good management has an even more important task based on the recognition that the workers are not herds but individuals with hopes and aspirations, people to lead rather than drive. In the old family concern the boss—"old Mr. Tom"—knew most of the work-people by their given names and something about their hobbies ; to-day this is much more difficult, especially when an overworked general manager has several thousands under him. Much can, however, be done, and it may be of interest to give an account of efforts made in a large factory employing both sexes some twenty-five years or more ago, largely before general interest was attracted to such questions.

The work is conveniently grouped under the headings of education, recreation, health ; we anticipated Hitler in devoting most of the efforts to the young people, remembering both that they are most impressionable and are continuously growing up.

Education. All young persons, as the Factory Act calls them, had to pass a certain standard before being taken on. The girls had to pass the top standard to qualify for the 'cleaner' work, for which there was always a long waiting list. The top standard was also required for the laboratory, to which a limited number were recruited each year after an interview by the chief chemist. The laboratory was regarded as the training ground for the staff. Everyone in it had to go to evening classes at the expense of the firm, at first in the home town and afterwards at the nearby city, to which travelling expenses were paid : some obtained external B.Sc. degrees in this way. (This was before the days of occasional day-time release which Dr. A. P. M. Fleming has since sponsored.)

At the end of the year the progress of each man was reviewed and a few 'square pegs' discharged. It was considered fairer to do this at the start than let them grow old in jobs for which they had little aptitude and probably less inclination. Such a system gives a larger number of recruits the chance of making good. Payment was by an age scale. The laboratory lads were encouraged in every way to take part and help in the social work and to develop any talent for organization or leadership. One got to know them well and to select those best fitted to be under-managers, alternatively research assistants. To-day some of them are managers in responsible positions.

On a smaller scale, the same progressive training was extended to the technical director's personal staff, which handled all works questions not pertaining to the actual processes. It was ripe for extension to the whole works, where any promising boy, generally discovered through the Scouts, was picked out and given a chance.

The advantage to the lads of this training is obvious : what the firm gained was a reservoir of men of all grades of ability available to fill gaps at home or abroad. We knew them and they knew our methods, a system which was infinitely more satisfactory than bringing in strangers.

Recreation. It is essential that the workers should manage their own affairs, but they need and welcome guidance in their organization. They do not want recreation arranged for them by a welfare staff. Our Girl Guides were highly successful, there was a waiting list to join them and a high standard of conduct was set ; here more than anywhere was there an opportunity of teaching the team spirit. The Boy Scouts were also popular, but the boy at this age very properly is more inclined to go his own way.

The company had provided a particularly fine recreation hall and canteen, including a theatre, which was the centre of a variety of activities all managed by the work-people and staff. The most interesting were the dances, sectional or large, which were self-supporting. These were visited by the technical director and certain members of the staff and their ladies—there was no formality or segregation. We were told our presence was desired and helped to make the affairs a success. I have no more pleasant recollection than the comparison of the dresses and general appearance of the girls at the beginning of these efforts and fifteen years later, and the young men had equally progressed. This social progress was in itself ample payment for much time devoted to this work—the girls made better marriages as one consequence of it. The credit was due in particular to the tact and general self-sacrifice of our lady manager, but it was personal also to a surprising extent, for on a change of management which withdrew the personal touch, the social functions languished and became less successful.

Interdepartmental games are a good method of fostering pride in the departments, and competitions for shields and cups, which are exhibited in the workshop all the year, do a lot of good in making workers feel they are part of a large family and not mere hands. The success of these, however, depends on a display of interest in them by the management ; they tend to die away if left to the players themselves.

We never found a means of really breaking down the barrier between works and office on the social side—a stupid distinction which in reality was non-existent—for the many offices in the works counted as works staff and played with us. Perhaps we did not try hard enough and left the office folk to find out what they were missing.

Health. The health of the worker should be a matter of concern to management. Quite apart from occupational diseases and epidemics, undue sickness in any one department is a sign that something is wrong and needs investigation. Departmental as well as general statistics should be reported. An undue amount of sickness among the girls led to the discovery that in order to get to work in time in the morning, many of them neglected to have a proper breakfast. A 40-minute-later start, that is, a 44- instead of a 48-hour week, was tried as an experiment, with an agreement on the part of the workers that they would try to maintain output and on ours that they would not lose pay. When things had settled down, it transpired that in the long run a slightly larger output was obtained and the sickness figure fell considerably. A watch on the sickness figure of small sections usually led to the discovery and rectification of the cause.

Many sections of the firm were working under conditions of limited floor space while new buildings were under way. Increased demand could not therefore be met by putting on extra girls, but only by higher production from the pieceworkers. To this end we made what are now called motion studies, an operation requiring the greatest tact. Varying rest periods, change of work so as to bring another set of muscles into play, height of seat and accessibility of components were all studied, with the result that we were satisfied that we did obtain the highest output per girl (paid for as piecework) that could be kept up day by day for a number of weeks. On one occasion the opportunity presented itself of working in circumstances in which the same girls, at their own wish, did even more, working for three days only per week. They kept this up for two weeks and then asked to give it up; the strain was too great and they found themselves tired for the rest of the week.

Overtime should be sparingly used for young persons; older men like it to provide a bonus for holiday occasions, but in the long run the same amount of work was done as if only normal hours had been worked.

Motion study under a special officer is to-day a regular practice, and much can be done to make the work easier. On the whole, operatives like monotony, something they can do with their fingers mechanically while they chatter and sing. They are suspicious of change unless they feel they have absolute confidence in the fair dealing of the management, and in particular a right of personal appeal to the top.

One of the most difficult things is to get hold of ideas from the workers to improve the process. There is the fear that the foreman will annex it as his own, or that if one goes past him that he will take it out of the individual. Suggestions boxes too often contain claims regarding alterations which the engineers already have in hand. The more management at the top knows the work-people, the easier it is to get a hint here and there where the shoe pinches, and to take equally quiet methods to put the trouble right.

Our wages were a few shillings above the local average, so that living on the same scale our peopl were just that amount better off. They were extraordinarily generous, as English working-people are giving freely to help fellow-workers in adversity an to causes sponsored by us which commended themselves. Perhaps I should say that all this wa largely before the advent of the cinema, which ha done so much to absorb the loose shillings from th people's pockets.

We were always seeking methods of giving extr benefits to the work-people, partly as a means o profit sharing, partly to shield them in adversity, an partly also with the hope of retaining our labour an not having constantly to take on new people. Thi aim was achieved, for our labour turnover was one o the lowest in Great Britain. We were early in th field in granting holidays with pay, depending onl on good time-keeping. We gave a weekly wag bonus for length of service. We started pension depending on the will of the board—non-contributor because any fund on an actuarial basis would hav been too costly. We postponed co-partnershi because of fluctuating profits—workmen do not lik the years in which no dividend is paid.

Perhaps our greatest success was group lif insurance—every man of long enough service wa given a policy for a year according in amount to hi standing and the report on his general proficiency. The minimum was £100, and many workers had twic this. The realization by the married man that i anything happened to him his wife and childre would receive what seemed a large sum—enough t start a small shop and keep them from want—had a profound effect on his well-being. The cost was considerable, but I am sure we should have been amply repaid.

Perhaps what has been said is enough to portray a restless management always seeking to make work happier for all and to better the lot of the worker both at work and at home. A loyal band of helpers found zest in the cause while our reward was close at hand. Needless to say we had no strikes, a very minimum of friction in spite of the fact that externally the years were very difficult ones, and a loyal response to any extra effort for which we asked.

The function of management *vis-à-vis* the worker is necessarily to drive, but when both sides understand each other, 'drive' becomes largely 'guide'.

E. F. A.

PHYSICAL FEATURES OF COMET 1941*c* (DE KOCK)

R. H. STOY has described (*Mon. Not. Roy. Astro. Soc.*, **101**, 7; 1941) the chief physical features from an examination of 24 plates taken with the Cape astrographic refractor on 18 days between January 20 and March 6. The plates were projected on to a piece of paper with the aid of an enlarging lens and a 500-watt lantern, the main features of the comet being then sketched in. The orientation of the drawing and position angles were derived from the lines, the positions of which were known, and when these had been completed an attempt was made to match the outlines of the observed caps by known curves.

It is interesting to notice that in nearly every case it was possible to find a catenary that fitted satisfactorily. There was a remarkable similarity between the early appearance of this comet and Donati's Comet of 1858. Thus, Donati's Comet showed a dark division between the two principal tail streamers, and this feature was very pronounced in 1941*c*. The envelopes or caps were also very similar in both comets, and the shapes of most of these could be very satisfactorily represented by catenaries. In all these cases the departure from a catenary was in the sense that the observed curve was less divergent near its open end than was the catenary that fitted it best near its vertex.

This departure should indicate that the velocity of outflow from the nucleus of the matter forming these envelopes was steadily increasing, on the fountain theory of the formation of these caps, outlined by Eddington in *Mon. Not. Roy. Astro. Soc.*, **70**, 442 (1910). It is remarkable, however, that the linear size of the caps did not increase from day to day, as would be expected on the fountain theory, which indicates that the velocity of outflow from the nucleus of the matter forming the envelopes should steadily increase. From January 20 until 28, the date of perihelion, the inner caps grew brighter as they got smaller, but there is not the same amount of evidence available for the outer caps. What there is shows that these outer caps seem to have remained much about the same size, or in some cases to have expanded slightly before starting to contract.

A full description is given of the phenomena visible on the plates for each day when photographs were taken.

FIDDLER CRABS

JOCELYN CRANE has made important and interesting observations on these crabs ("Crabs of the Genus Uca from the West Coast of Central America." Eastern Pacific Expeditions of the New York Zoological Society. XXVI. *Zoologica*, 26, Part 3; Oct. 31, 1941). The present paper deals with specimens taken on the *Arcturus* Oceanographic Expedition (1925), on the Eastern Pacific *Zaca* Expedition (1937–1938) and on a special trip made to the Pacific shores of Panama by Miss Crane herself in January and February 1941.

The studies of habits and behaviour made on this last trip embrace a large amount of new knowledge on the ecology and especially the courtship display and mating of these crabs. Twenty-seven species are accurately described, eleven being new to science. There have been different opinions about the meaning of the waving of the large claw in fiddler crabs, but it is quite definitely established by these observations that this waving of the large claw, at any rate in the region investigated, is primarily for the attraction of the female, at least during the breeding season, and only secondarily for the warning off of crabs trespassing on a male's feeding range. This waving is only a part, or step, in a definite courtship display or dance which varies so greatly with the species that individuals can be recognized at a distance by their characteristic motions.

The patience which such studies necessitate is enormous, whole periods between tides being utilized and individual crabs kept under observation for many hours. The quality and quantity of the results show that such patience is amply rewarded, and Miss Crane is to be congratulated on the completion of a valuable contribution to the study of crab behaviour. Detailed colour notes are also given of all the crabs described; these colours vary enormously at the breeding season and at the time of display. "Courting adult males, in contrast to other adult males, and, of course, to females and young, change colour daily upon exposure to sunlight within the space of a short time—a few minutes to an hour or more being required. . . . That courtship coloration and display play a definite part in sexual recognition is certain, that they play one also in sexual selection is likely, but has not yet been proved by experiment."

A phylogenetic tree of the species dealt with is suggested and a key given to the species of Uca occurring on the west coast of America and in the Galapagos Islands.

NATIVE SUBSISTENCE ON THE AMERICAN CENTRAL PLAINS

IN a recent paper, W. R. Wedel dealt with man's battle against Nature in the great plains of Kansas and Nebraska (*Smithson. Misc. Coll.*, **101**, No. 3: "Environment and Native Subsistence Economics in the Central Great Plains". Publ. 3639. Pp. ii+29+5 plates. Washington, D.C.: Smithsonian Institution, 1941.) This region of widespread droughts, dust-storms, and consequent crop failures has been for some centuries the scene of attempted cultivation—sometimes successful, sometimes not. In view of recent failures the author has been collecting archæological evidence which tends to show that the aboriginal groups that exploited this region at various times and in various ways were themselves faced with similar adverse climatic conditions. In the western portion of this territory lies part of the High Plains province and immediately eastward of this is a stretch of sandy country now used for cattle rearing as the loose sandy soil renders it impracticable for agriculture on a large scale. Before the advent of the white man all this portion was roamed over by herds of bison, followed by nomadic tribes of Indians who preyed on them and on other abundant game. But farther east there is the great loess plain, fertile and well suited to agriculture and which was formerly inhabited by groups of Indians who cultivated the soil and made semi-permanent settlements. That these never became permanent was probably owing to the recurrent bad seasons—mainly droughts—that then, as now, might last for some years.

Archæological evidence goes to prove that groups of people did succeed at times in wresting a living even in the more inhospitable zones of the dry belt; as proved by sites containing the remains of charred corn and bone hoes, together with such quantities of animal bones as suggest that hunting was the main economy and horticulture a side line. In these circumstances the vagaries of the weather would play a less important part than in a wholly agricultural community. Droughts undoubtedly occurred in prehistoric times, the dust storms that accompanied them forming deposits over the sites.

In historic times great droughts occurred causing large population movements of the white settlers and reducing the Indians to the borderland of starvation. But it must be borne in mind that the old cultural patterns of the Indians were already broken by contact with the whites and they had not had sufficient time to re-adapt themselves. It is likely that in pre-white times they might have weathered these droughts as they were of comparatively short duration, although severe.

The author came to the conclusion that it is unlikely that any major climatic change has taken place in the central great plains within the last thousand years, and that alternate settlement and abandonment of this area was as true of primitive man as it is of white man's tenure when large-scale government aid has not come to his rescue.

EARTHQUAKE ORIGINS IN THE NEW ZEALAND REGION

R. C. HAYES, acting director of the Dominion Observatory, Wellington, New Zealand, has been investigating the origins of earthquakes in New Zealand ("Earthquake Origins in the New Zealand Region". Dominion Observatory Bulletin No. S.62). Using new material and improved methods, Hayes has redetermined the epicentres and depths of focus of several earthquakes in the New Zealand region for the years 1931 and 1936–40 inclusive, and has prepared a map showing these epicentres.

From these results it is evident that while the general distribution of earthquake epicentres does not differ appreciably from that indicated in earlier years, the more recent results bring out certain features which were not evident before. For example, the extensive seismic region, covering the eastern and southern parts of the North Island, Cook Strait area, and the northern part of the South Island is seen to have a sharply defined boundary on its north-west side, concave towards the north-west. It crosses the North Island from the Bay of Plenty to the region north of Cape Farewell, and there are very few earthquakes to the north-west of this line. Deep focus earthquakes may be significant.

Many of the shocks originating in the Gisborne – East Cape region and farther eastward have focal depths greater than normal. Origins at depths of 60 km. or more are common in the northern Hawke's Bay and Gisborne regions, the depths tending to increase up to about 100 km. for the submarine shocks farther eastward. Shocks originating in the south-west of South Island also have depths of focus of nearly 100 km. An isolated origin deeper than normal has been located near the north-eastern extremity of South Island (80 km.).

There is another zone, marked by origins at depths ranging up to 300 km. or more, which extends from near White Island in the Bay of Plenty to the region of Lake Taupo, a zone corresponding very closely with that in which volcanic activity occurs. The greatest depth of origin so far recorded in this zone is 320 km. (nearly 200 miles).

An important feature regarding the distribution of deep shocks which is indicated by the present results is their location with respect to the normal shocks in their vicinity. In most regions around the Pacific, deep-focus shocks tend to congregate away from the Pacific, the normal shocks being located on the Pacific side of them. This is clearly the case in the North Island of New Zealand, where the deep-focus zone has an extensive region of shallower or normal shocks to eastward of it.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public.)

Monday, February 2

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. B. A. Keen, F.R.S.: "Soil Physics, Theory and Practice" (Cantor Lectures, III).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Dr. G. H. C. Hart: "Recent Development in the Netherlands Indies".

Wednesday, February 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. H. G. Jenkins: "Fluorescent Lighting".

Thursday, February 5

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. A. W. Ashby: "The Rise of Efficiency in Agriculture".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DISTRIBUTION ENGINEER to the Tees Valley Water Board—The Engineer and General Manager, Water Board Offices, Corporation Road, Middlesbrough (February 5).

CHIEF ELECTRICAL ENGINEER AND MANAGER of the Accrington Electricity Undertaking—The Town Clerk, Town Hall, Accrington (February 9).

SECRETARY-STEWARD IN THE DEPARTMENT OF PATHOLOGY AND BACTERIOLOGY—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (February 10).

HEADMASTER of the King Edward VII School for Boys, Lytham—Messrs. Wilson, Wright and Wilsons, Clerks to the Governors, 6 Chapel Street, Preston, Lancs. (February 13).

MAN OR WOMAN TO TEACH MATHEMATICS AND MECHANICAL DRAWING—The Principal and Organizer of Further Education in Rugby, 61 Clifton Road, Rugby.

ASSISTANT MASTER in the Technical School of the Royal Aircraft Establishment to teach Mathematics, Mechanics and Machine Drawing—The Central Register (ONC 745), Queen Anne's Chambers, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 46: A Strain of the Tuber Blotch Virus causing Top Necrosis in Potato. By Phyllis E. M. Clinch. Pp. 435-445+plate 8. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s.* 6*d.* [61

British Chemical Plant. 1941 Official Directory. Pp. 190. (London: British Chemical Plant Manufacturers' Association.) Gratis. [91

A Twentieth Century Economic System. Pp. 60. (London: Economic Reform Club.) 6*d.* [121

Tin Research Institute. Publication No. 107: Hot-tinning 'Difficult' Mild Steels. By W. E. Hoare and H. Plummer. Pp. 28. (Greenford: Tin Research Institute.) Free. [121

Other Countries

Smithsonian Institution: United States National Museum. Bulleti 50: The Birds of North and Middle America: a Descriptive Catalog o the Higher Groups, Genera, Species and Subspecies of Birds known t occur in North America, from the Arctic Lands to the Isthmus o Panama, the West Indies and other Islands of the Caribbean Sea, and the Galapagos Archipelago. By Robert Ridgway, continued by Herber Friedmann. Part 9: Family Gruidae—The Cranes; Family Rallida —The Rails, Coots and Gallinules; Family Heliornithidae—The Sun grebes; Family Eurypygidae—The Sun-bitterns. Pp. ix+254 (Washington, D.C.: Government Printing Office.) 40 cents. [1

Smithsonian Institution: Bureau of American Ethnology. Bulleti 131: Peachtree Mound and Village Site, Cherokee County, Nort Carolina. By Frank M. Setzler and Jesse D. Jennings; with Appendix Skeletal Remains from the Peachtree Site, North Carolina, by T. D Stewart. Pp. ix+103+50 plates. (Washington, D.C.: Governmen Printing Office.) 40 cents. [1

U.S. Department of Agriculture. Farmers' Bulletin No. 1884: The Sugar-cane Borer. By J. W. Ingram and E. K. Bynum. Pp. ii+17 5 cents. Technical Bulletin No. 783: Selenium Occurrence in Certai Soils in the United States, with a Discussion of Related Topics: Sixt Report. By H. W. Lakin and H. G. Byers. Pp. 27. 5 cents. (Washington, D.C.: Government Printing Office.) [1

U.S. Office of Education: Federal Security Agency. Educatio and National Defense Series, Pamphlet No. 13: Hemisphere Solidarity; a Teacher's Guide on Inter-American Relations, with Specia Reference to Latin America (for Senior High Schools). Pp. vi+23 (Washington, D.C.: Government Printing Office.) 15 cents. [1

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FUTURE OF THE CIVIL SERVICE

ALTHOUGH the Civil Service in Great Britain has received a considerable amount of criticism in recent months, the basic qualities and technique which have won for it the admiration of the world cannot be discarded without imperilling the execution of that new conception of government which should inspire policy to-day. To develop and modify rather than to destroy tradition and technique should be the object, and while Lord Stamp may have been right as to the unsuitability for higher administration of the exactly trained Civil servant, given to the analytical application of a legislative programme in a statute, co-operating with other departments similarly bound, and working to the elaboration of a complete static programme to be generally applicable by principle and precedent, this is not to say that his essential qualities are not required. Thoroughness ; accuracy of statement and precision of reasoning ; a proper respect for precedent ; the capacity to get quickly at the real gist of a situation and to set out the points briefly and lucidly ; the power of writing for public consumption, both vigorously and cautiously ; a strong dislike of muddle and irregularity in procedure ; a wide acquaintance with the machinery of government and a close acquaintance with two or three parts of it ; and a subconscious instinct for what can be said and done and what cannot—these characteristics will be valuable and essential whatever changes in organization and outlook are introduced.

The growth of the Service, and the struggles through which its tradition and strict code of conduct have developed, have been well set out by Emmeline W. Cohen in a recent work (see NATURE, Nov. 22, p. 601). Now Mr. H. E. Dale, himself a Civil servant with a distinguished career who retired in 1935, has given* an interpretation of the mind of those higher ranks of the Service who are primarily concerned with policy and are in immediate contact with Ministers. He limits himself to the conditions which existed up to September 1939, and within that qualification his admirably written book gives a very human picture of the life and work of the administrative class, more intimate, indeed, than that given in such biographies of Civil servants as Bernard M. Allen's "Sir Robert Morant" or Lady Murray's more recent "The Making of a Civil Servant". Indeed, this most readable volume should be as welcome to those considering the Civil Service as a career as it is relevant to the discussion of the place of the Service in the machinery of government to-day.

Mr. Dale attempts to describe and analyse, first the nature of the original human material from which the higher permanent official is recruited, and secondly the processes which have contributed to his making. Facts and opinions are kept clearly apart, and although it might be held that Mr. Dale is a little optimistic in holding that the Civil Service will emerge relatively little changed from the present struggle, and some of his conclusions are tinged with complacency, this does not detract from the merits of a really well-written book. The delineation of the positive merits of the Civil servant, which is the strongest feature of Mr. Dale's book, redresses to some extent the balance in controversies which have concentrated excessively on his weaknesses or deficiencies.

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* The Higher Civil Service of Great Britain. By H. E. Dale. Pp. xiv+232. (London : Oxford University Press, 1941.) 10*s*. net.

The basic qualities and technical craftsmanship acquired as the Civil servant rises in the Service lead to a habit of mind or a conscious or subconscious creed. Compressed by Mr. Dale into five propositions, it is probably shared in some degree by most professional men, and it gives a clue to some of the real weaknesses of the Service. First, pure reason is not at present the most important factor in human affairs. Second, even in the realm of pure reason, there is much to be said for both sides on any complicated question which is fiercely disputed. Third, in a vast and highly organized society, great social, economic and political changes cannot be made quickly without arousing widespread opposition, much of it natural and reasonable, and without causing some unmerited suffering. Fourth, a minority which feels strongly and shouts loudly will often prevail both against the majority and the merits, unless the majority itself feels strongly. Fifth, in this complex and rapidly changing world, the strongest intellect and the keenest insight cannot predict anything like the full consequences of important decisions.

Such qualities of mind and outlook clearly favour the doctrines of moderation and prudence rather than opportunism. They are not necessarily inconsistent with the capacity to accept responsibility, although Mr. Dale more or less admits the tendency to leave well alone, and that preoccupation to keep a department out of trouble may influence conduct more powerfully than a desire to promote far-reaching projects. Indeed, when it is maintained that the Service takes power rather against its will and because otherwise the government of the country could not be carried on, Mr. Dale tacitly admits that the dislike of the Service for bureaucracy has not altogether prevented its expansion from being attended by a certain growth of evils associated with bureaucracy.

The evidence of Mr. Dale's book supports the central theme of a recent P E P broadsheet that the weakness of the Civil Service flows essentially from an obsolete conception of government as a regulatory, policing and taxing mechanism. Until a new conception of the function of government as the nation's instrument for planning, safeguarding and developing the collective inheritance and the social and economic welfare is recognized and adopted, with all the changes it involves in both the outlook and in the organization and methods of the Civil Service and its relations to Ministers, we are unlikely to secure the more constructive type of administrator, who sees opportunities and possibilities rather than difficulties and dangers, and possesses creative ability and the capacity for rapid and energetic action. That positive conception of administration and government is poles asunder from the retreat to individualism and chaos masked under Lord Perry's attack in "Beware Bureaucracy".

On the charges of lack of foresight and lack of knowledge of the new techniques of large-scale organization and management, or of science and scientific method or technique, Mr. Dale offers no evidence. He dismisses as pure nonsense the notion that the administrators despise or disregard the technical, and he maintains that the idea that in the ordinary office staffed entirely by Civil servants there is any habitual lack of co-ordination has no substantial basis of fact. On neither point is he convincing. The reports of the Select Committee on National Expenditure have provided disconcerting evidence of the existence of departmentalism, and there can be little doubt that the fuller use of the technical expert is one of the major future problems of the Service, and thought should be given to it immediately.

The picture Mr. Dale gives, however, scarcely supports the charge that the permanent Civil servant is out of touch with affairs, though the Post Office practice of insisting on provincial service as a preliminary to administrative work at headquarters could obviously be extended with advantage. Nor does it suggest that there is anything inherently opposed to such charges as are outlined in the P E P broadsheet, provided there is no shirking of the issues involved in disseminating throughout the Service a new outlook and new methods, and cutting out 'dead wood' where necessary. Much more than the two periods of long leave suggested by Mr. Dale will be required if the Civil servant is to adapt himself effectively to the new conception of government.

Much stress is laid on the changing relations of social rank between the high official and his Minister. The diminishing degree of homogeneity of the Service as compared with forty years ago is probably a more important and beneficial factor, but it is a matter of opinion whether the homogeneity of the main body of high officials, in spite of their individual differences, is really a source of strength to the Government, or to the public advantage.

A less beneficial change noted by Mr. Dale, as well as by Lord Perry, is the tendency for brilliant men to leave the Government service for employment outside it while in the prime of life. Dr. W. A. Robson has already stressed the need for greater mobility between the Service and the outside world, but in this drift from the Service the footsteps all point one way. Continuance of this tendency would be a serious matter, and when we couple with it the fact that the effect of the War of 1914–18 on the Higher Civil Service is about at its maximum, and that the effect will only disappear during the next decade or so, the comparative impoverishment of the Service can be readily understood. Such considerations support Sir Arthur Salter's argument for reinforcing the personnel of the Civil Service at the top with leading men in industry and science, and throughout its ranks with young men of energy and constructive ability—a policy to which Mr. Dale is firmly opposed for reasons which could equally well apply both ways.

In this detached but somewhat complacent picture of the upper six hundred in the Civil Service, there is evidence justifying the comment of *Planning* on the existence of chronic and avoidable overwork, frequently leading to breakdowns of health, not due to an excessive amount of work performed but to a failure to organize its performance. Such conditions lead readily to the lack of interest in and awareness of the technique of administration as a science, as well as to the absence of specialized services watching the working of the machine in relation to its current agenda and helping to keep it up to scratch in such matters as office organization, statistical methods, record-keeping and messenger services, and the failure to move the staff in accordance with changing demands. Very clearly we have as yet no thinking and planning organ free both from the immense pressure of day-to-day administration and from the intellectual tyranny of the departmental hierarchy and its departmental outlook, and at the same time in close enough relation with the responsible departments to keep it realistic and practical. The stress of war merely shows up limitations which were already becoming apparent in peace, and which are overdue for attention if the growth of the Civil Service is not to become a danger rather than a help to democratic government.

These problems of organization and of the adaptation of the Service to serve the increasingly complex needs of modern society are among the important tasks awaiting attention. A further problem is that of establishing such a relation between the Civil Service and the new semi-public services that there shall be no danger of a conflict between the two, or of a creeping back of abuses from which the Service was freed by strenuous efforts in the past. Both Emmeline Cohen and Mr. Dale, like Mr. T. H. O'Brien in "British Experiments in Public Ownership and Conrol", point to the dangers attendant on the great disparity between the salaries of highly placed Civil servants and those in control of these recently created bodies. In many ways, the responsibilities of these two groups are comparable, and steps should be taken to deal with the matter before an unfortunate precedent is established.

The first step must clearly be, as the P E P broadheet insists, the adoption of a new and positive conception of government. That is fundamental to the establishment of the organization and machinery for planning ahead, for adjusting continuously the working structure and technique of government to the problems with which it is called upon to deal, for overthrowing the domination of financial and accountancy considerations, for the neglect of scientific and technical advances and timidity in taking responsibility. Although the initial stimulus may come from without, the Civil servant should be grateful for the vidence which these recent sympathetic but balanced studies afford that, given the necessary measures of reform in personnel and organization, the main bulk of the Higher Civil Service will prove fully competent o grasp boldly and imaginatively the immense opporunities before them, and to discharge the more ositive functions demanded to-day without impairng the high traditions and code of conduct they nherit from the past.

PROTOZOOLOGY IN THE UNITED STATES

Protozoa in Biological Research

Edited by Gary N. Calkins and Francis M. Summers. Pp. xli+1148. (New York: Columbia University Press; London: Oxford University Press, 1941.) 66*s*. 6*d*. net.

SINCE the title of this heavy volume is somewhat vague—and its cost prohibitive, in present circumstances, to most British biologists—a brief description of its scope and contents will be more serviceable than a detailed criticism. The book actually contains twenty chapters of unequal length and quality, by as many American authors, dealing with a score of miscellaneous topics of more or less urgent interest to present-day protozoologists. According to the preface, the work is not a "textbook" on the Protozoa, but is intended "to stimulate further research on these unicellular animals".

Chapter i is entitled "General Considerations", and is by the senior editor. Chapter ii, by H. W. Beams and R. L. King, deals with some physical properties of protozoal protoplasm. Chapter iii, by R. F. MacLennan, summarizes recent work on cytoplasmic inclusions. C. V. Taylor discusses the fibrillar systems of ciliates in Chapter iv; and S. O. Mast deals with the motor responses of various protozoa in Chapter v. Chapters vi (on respiratory metabolism, by T. L. Jahn) and vii (on contractile vacuoles, by J. H. Weatherby) are also physiological. In Chapter viii G. W. Kidder—under an ambiguous title—describes some recent attempts to obtain bacteria-free cultures of Protozoa. Food-requirements and growth-factors in cultures are analysed by R. P. Hall in Chapter ix; while growth in general is discussed by O. W. Richards in Chapter x. C. A. Kofold then (Chapter xi) discourses on the "Life Cycle of the Protozoa". The four following chapters (xii–xv) are of genetical interest, and discuss fertilization (J. P. Turner), endomixis (L. L. Woodruff), sexuality (T. M. Sonneborn), and inheritance (H. S. Jennings). F. M. Summers next reviews some "morphogenetic problems" (Chapter xvi); and the volume concludes with four chapters (xvii–xx) on subjects of parasitological importance—pathogenicity (E. R. Becker), immunology (W. H. Taliaferro), host-parasite relationships (H. Kirby), and the parasites of the Protozoa themselves (by the same writer). The authors' names will afford sufficient indication of their present status in the protozoological firmament.

Each chapter is followed by a list of references, and there is a copious index at the end. There is also a lengthy "list of abbreviations" (of titles of journals cited) at the beginning (pp. xxvii–xli): but as these are mostly identical with those in the generally accepted "World List", the reason for their inclusion is not evident. It must be added that the get-up and printing are good, and few serious misprints have been detected. (On p. 449, however, "irradication"—for eradication—presumably reverses the author's intention.) The text is fully illustrated with 21 tables, 226 figures, and four half-tone plates. It is, in fact, what is commonly called "a mine of information" on the various subjects dealt with, and will undoubtedly be of great use to those who can refine the precious metal from the dross—a laborious and perhaps impossible task which the present authors can scarcely be said to have achieved everywhere.

With a few notable exceptions the articles are neither impartial reviews nor critical summaries of recent work—with full analyses of the international literature—but rather disquisitions on particular aspects of the various subjects which happen to interest the particular authors concerned. Much that is said is therefore to be found in earlier publications by the same writers, while much relevant research by others is ignored (or merely included, without discussion, in the appended references). Evidence may even be found, in more than one passage, that the "specialist" or "authority" is not himself always familiar at first hand with all the matters of which he treats. In general, American work is emphasized, and the pictures presented are thus not always complete or satisfying to a British worker in the same field. Two glaring instances will illustrate these points sufficiently. (1) The senior editor, in his introductory chapter, rehearses "some historical facts" about the Protozoa. Their discovery is here attributed to "Anton von Leeuwenhoek"—as it was in the same author's treatise of 1901. He thus appears to be still unaware that a vast amount of work has been done on Antony van Leeuwenhoek—especially in England and Holland—during the last forty years, so that there is no longer any excuse for germanizing his name or misquoting his words. Moreover, "Ludwig Hamm"—cited both in 1901 and in 1941 as the discoverer of the spermatozoa—is now a notorious ghost. (2) On p. 572 there is a figure of "the life cycle of *Endamœba coli* (= *Councilmania lafleuri*, Kofoid and Swezy, 1921)". But the real and very different life-history of *E. coli* is now known; and "*C. lafleuri*", as here depicted, is not recognized outside the author's own laboratory in California.

On matters of history, and on general biological principles, other authors also appear to be sometimes strangely misinformed. Moreover, their individual views are not always consistent; though this is to be expected, and perhaps welcomed. Yet it seems curious that not one of them appears to understand the interpretation of Protozoa as *non-cellular organisms*: so that while the editors (and some others) still regard them as "unicellular", we are told (on p. 578) that "it is biologically medieval to refer, as do many textbooks and other works, to *Paramecium* as a unicellular organism". Unfortunately, the writer then concludes that it must be "multicellular"—being unable, apparently, to appreciate the difference between cells and nuclei. For him the terms "multicellular" and "multinucleate" are seemingly synonymous. Such confusion of ideas may surely be called biologically prehistoric rather than medieval.

It would be easy to find fault with many another inconsistency in this book, and to criticize its lack of coherence and direction; for it appears to enunciate no new general principles, and scarcely succeeds—if that is its intention—in correlating recent research on the Protozoa with general biological concepts. Yet for my part I am grateful to my American colleagues, both old and young, for stating—or restating—their own views; and, with other British protozoologists, I envy them their ability to spread themselves so lavishly and unconcernedly in these difficult and disturbing days. All the same, I doubt whether this kind of publication will encourage further research of any real value—the one thing we all have at heart. I can only hope that my own misgivings are unjustified, and that other workers—younger and better and less constrained—may find inspiration where I have sought it in vain.

Clifford Dobell.

FORMULÆ AND TABLES FOR THE BOTANICAL LABORATORY

Plant Science Formulæ

A Reference Book for Plant Science Laboratorie (including Bacteriology). By Prof. R. C. McLean an Dr. W. R. Ivimey Cook. Pp. vii+203. (London Macmillan and Co., Ltd., 1941.) 7*s.* 6*d.* net.

IN botanical laboratories each individual worke tends to introduce modifications of methods o fixation, staining, etc., according to the particula requirements of his material and investigation; th result of this is that descriptions of methods becom so multiplied as to be very confusing to an occasiona worker in that branch of the subject, and much tim may be wasted in looking up and deciding betwee the many possible methods of carrying out any on procedure. In course of time most workers tend t collect their own card index of selected methods an the authors state that this book is in fact their car index put into a more convenient form. For specialized methods the index will still be required, but i "Plant Science Formulæ" may be found the receipts in the generally accepted form, of the commonly use fixatives, stains, culture media, etc., given in th *simplest form and with the minimum of inessentia* detail. It is inevitable in such a book that an specialist worker is liable to find certain method omitted or differing from those he is accustomed t use, and for this reason blank pages are inserted a the end of each section for additions.

As the authors point out, this is essentially a boo to have at hand in the laboratory and would los much of its purpose if put away on the library shel The receipts for technique are followed by sections o the various necessary accompaniments of laborator work, either of the laboratory steward, researc worker or teacher, as, for example, information o photographic work and preparation of lantern slide and museum specimens, odds and ends of informatio for the workshop, tables of weights and measure atomic weights, various physical formulæ and constants and logarithm tables, so that the author have made a very real attempt to collect into on book all the miscellaneous facts and formulæ whic are continually being required in the laboratory an are scarcely ever readily available.

The authors stress the point that the aim of th book is also to help the teacher who commences wor in a school or technical institution with nothing mor than the usual college training in the use of certai methods with reagents supplied ready prepared. I is hoped that such students have had sufficien training to enable them to make up reagents, cultu media, etc., given the receipts and sufficient dire tions, and to such as these, who also often have litt access to books and little time for searching ou directions, this book should prove extremely usefu For this class of reader there are also included lists the general requirements for the laboratory and th addresses of suitable firms who supply chemical microscopes and biological materials.

In some cases reference to sources of the metho would have proved useful for further details as t methods, but probably the book in its present si and price will meet a wider need than a larger an more expensive volume. The book will certainl prove of very considerable value if used, as th authors intend, essentially as a laboratory book t which constant reference may be made.

ANALYSIS OF FOODS

Food Analysis

Typical Methods and the Interpretation of Results. By Prof. A. G. Woodman. (International Chemical Series.) Fourth edition. Pp. xii+607. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 28*s*.

THIS is the fourth edition of a work originally published in 1915, and the declared intention of the author was then, and still remains, to provide a guide to students of analytical chemistry as applied to foodstuffs. A casual inspection of the contents at first suggested that there were some surprising omissions, but such criticism is promptly disarmed by the author who explains that his method was to select certain typical foods only, and to treat them at considerable length, so as to present the student with examples of the technique of food analysis rather than to cater for the requirements of the practising chemist.

While these intentions have been very ably carried out, it nevertheless seems to the reviewer that some of the material could usefully have been treated less generously, so that common foods such as cheese or dried milk might have received at least a mention; and that in six hundred pages devoted to food analysis, even if only for students, the word 'vitamin' deserves a place.

The first three chapters deal respectively with general methods of examination both physical and chemical, food microscopy, and colours and preservatives; here, as indeed throughout the book, the theoretical considerations involved in the various methods described receive adequate and capable treatment. One might query the statement concerning the presence of sulphurous acid and sulphites in foodstuffs that "there is no simple reliable qualitative test".

The section devoted to milk is fairly complete and up to date; the names of Gerber and Werner-Schmidt do not occur and one notices that the average fat content in the United States is apparently higher than in Great Britain (4·0 as compared with 3·7).

The general discussion of the examination of edible fats and oils, as well as that of the selected examples, namely olive oil and butter, is excellently written; it was noted that no mention is made of peroxide value. As with each of the typical foods dealt with throughout the book, the important question of the interpretation of results is carefully considered; this subject is often badly neglected, as more than one examination candidate has found to his cost.

Following a comprehensive description of the methods in common use for the analysis of carbohydrate foods, with particular attention being devoted to sugars and certain chosen foods, the remainder of the book deals with spices, cider vinegar, flavouring extracts and alcoholic beverages, more than one sixth of the whole book being allotted to the last-mentioned subject.

Woodman is very 'readable', and his book, in which no typographical errors were detected, is much less obviously American than most scientific publications from across the Atlantic. While many of the diagrams and tables have a familiar appearance, their source is invariably indicated with due acknowledgment. Very full references are given in footnotes and at the end of each chapter a list of books is given to which the attention of the student is directed for further study.

A. F. Lerrigo.

MATHEMATICAL REQUIREMENTS FOR STATISTICS

Statistical Procedures and their Mathematical Bases

By Dr. Charles C. Peters and Prof. Walter R. van Voorhis. Pp. xiii+516. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 31*s*. 6*d*.

THIS book is the outcome of a serious attempt to derive accepted statistical methods and formulæ from elementary mathematics. It opens with a chapter called "A Little Calculus"; and it may be presumed that the mathematical proficiency of the reader marches *pari passu* with his reading of the book, for the later chapters are on such subjects as partial and multiple correlation, the normal curve, non-linear correlation, analysis of variance, curve fitting and so on.

The point of view of the authors is easily comprehensible, and merits sympathy. On one hand we have books such as R. A. Fisher's "Statistical Methods for Research Workers", which promulgate formulæ and procedure by the voice of authority, without descending to proofs; on the other we have few text-books, but a profusion of memoirs, not only abstrusely mathematical, but often controversial. A student or researcher, initially of slender mathematical equipment and desirous of applying statistical methods to some problem of research, may well feel at a loss. This book is intended to help him, and without doubt, by the time he has read its almost five hundred pages (the last thirty are devoted to useful tables) he will know a great deal about questions of distribution, correlation, regression, the χ^2-test and the rest. Will he be able to digest his knowledge and discriminate?

While fully sympathetic, one may feel dubious about the efficacy, and even the desirability, of such an approach. Envisage a continuous variate; the compound probability of even two individuals involves a double integral, and n-fold integrals with very large n are the merest commonplace. Consider again the question of partial correlation; the abstract underlying ideas are those of linear transformations and positive definite quadratic forms. Indeed not only the infinitesimal calculus, but also algebra, both matrix and combinatory, and some notion of the geometry of hyperspace are prerequisite to the study of statistics. It is better that these fundamental preliminaries should be mastered as if for their own sake. Then, when the time comes for application to mathematical statistics, one will have a background not merely for understanding and applying, but also for doubting and reserving an opinion; for high authority does not yet speak with a single voice.

A truly elementary and comprehensive book of this kind would have had to be at least twice as long again. For example, the normal function is deduced from the exceedingly special case, the symmetrical binomial; while the χ^2-distribution and many other results are only incompletely established, the reader being referred to more advanced treatments.

THE GENETICS OF SPECIATION

Genetics and the Origin of Species

By Prof. Theodosius Dobzhansky. Second edition, revised. Pp. xviii+446. (New York: Columbia University Press; London: Oxford University Press, 1941.) 28*s*. net.

DURING the last ten years geneticists have been getting to grips with the problems of evolutionary change; Prof. Dobzhansky describes the results of their work in this book. The first edition appeared in 1937, and it was reprinted two years later; but a second edition became necessary in 1941. These facts show clearly the great need for a book of this type. They also show how well Prof. Dobzhansky has filled that need.

Substantial additions have been made in the second edition, including one new chapter on "Patterns of Evolution", and reference is made to many original articles which have appeared since 1937. As before, one of the outstanding features of the book is the wealth of Russian material made available in English for the first time.

Genetics occupies a rather special place in experimental biology as it has always been concerned to a great extent with groups of individuals; indeed the laws of inheritance are most commonly used to define the statistical properties of such groups. This is, however, largely a reflection of genetical methodology since the older study of inheritance is at root the study of gene transmission from individual to individual and of gene action within the individual. Such a statement cannot be made about the newer development of population genetics. It is true to say that the genetical behaviour of a population depends ultimately on the behaviour of each constituent individual, but a new level of integration is reached because the population can have properties not possessed by, and not always directly predictable from, the individual. The emphasis which Prof. Dobzhansky lays on this point is not the least of the services which he has rendered to the genetical study of evolution.

In proceeding to investigate these special properties of populations two main lines of approach have been used, each of which is itself composite. In the first place there is the genetical and cytological analysis of samples taken in the wild, from which conclusions may be drawn regarding the genetical structure of the population and by means of which its behaviour may be compared with that of other populations related both in time and in space. Secondly, there is the attempt to infer the behaviour of groups of organisms from the known properties of single individuals. In both of these approaches genetics, cytology and statistical mathematics have played their parts in the past, and the ultimate understanding of population behaviour and of evolution depends on the successful combination of these various weapons in the future attack on the problems involved. Prof. Dobzhansky performs his second great service in bringing together the evidence which has already accrued in the different ways, in pointing out the conclusions to which this evidence leads and, perhaps most important of all, in exposing the deficiencies in our knowledge, while formulating working hypotheses which should help in guiding future attempts to fill these gaps.

If criticisms are levelled at the book, the most important will perhaps be that the advance on the older genetics is not greater. In following out the mechanism of inheritance, genes giving striking and easily identifiable effects were used of necessity; but in Nature one is concerned much more with those characters which depend on the combined action of many genes each having a relatively small effect on the phenotype. Species differences are polygenic, and just as the progress from individuals to populations involves a new integration, the properties and behaviour of polygenic characters are distinct from those of the so-called qualitative type used in the older genetical studies. It must, however, be said that Dobzhansky could have done little beyond directing attention to the necessity for a study of polygenic inheritance, for up to the present few investigations of this kind have been made.

A further point should be mentioned. The effect of population size on the spread and fixation of genes is discussed at some length, but it is not made clear that, inasmuch as the mating system, which may favour inbreeding or outbreeding of any degree of rigour, is always subject to genetical control of greater or less precision, the effective size of the population is itself a character on which selection will act and hence is adaptive. This must clearly have a profound influence on the interpretation which one places on the results of variation in apparent population size. Indeed, the whole notion of population size is rather vague unless a detailed knowledge of the breeding system is available.

The phraseology will seem to many to be somewhat unusual in a few places. In particular two mistakes, namely, the use of "indefinitely large" for "infinitely large" and the reference to the somatic number of chromosomes in polyploid wheat as the diploid number, are regrettable, because both are common errors which may have an extended life as a result of their unfortunate use in a book of such authority. These and their like are, however, minor blemishes and should cause the reader little trouble. "Genetics and the Origin of Species" is strongly to be recommended to all who, whether geneticists or not, wish to know how genetics can help in understanding evolution, and the extent to which it has already been used for this purpose. K. MATHER.

PSYCHOLOGY OF EVACUATION

The Cambridge Evacuation Survey

A Wartime Study in Social Welfare and Education. Edited by Susan Isaacs, with the co-operation of Sibyl Clement Brown and Robert H. Thouless. Written by Georgina Bathurst, Sibyl Clement Brown, John Bowlby, G. A. Bullen, Nancy Fairbairn, Susan Isaacs, N. S. Mercer, Madeline Rooff, R. H. Thouless. (Contributions to Modern Education.) Pp. ix+236. (London: Methuen and Co., Ltd., 1941.) 8*s*. 6*d*. net.

THIS book deals too compactly with too much detail to admit of any adequate summary within the limits of a review. To stress some of the implications of its title: it contains the findings of a team of experts, who, in organized co-operation, applied their special techniques of investigation to a local group of evacuated London children. The population under examination was therefore necessarily limited (though actually considerable in number), and the results, as the book makes clear, must not be too readily generalized. Yet the group was probably typical of the whole. It is beyond doubt that a study so careful and detailed as this of a relatively small and selected sample of the army of evacuees has more scientific value than a superficial description of a greater number of children, and the contributors have earned the gratitude of students in many fields by the promptness with which they seized the opportunity which was presented to them.

Few centres were so fortunate as Cambridge in finding such a varied team of experienced research workers at hand. Their methods are described in adequate detail. In the main they relied on a combination of statistical analysis and case histories. The statistical material, presented with the competence one expects from Dr. Thouless, is subjected throughout to qualitative examination. The general problem is studied from many angles, and all concerned, including the children themselves, are allowed to present their views. Relations in the reception homes, recreation, economic factors, the reasons for the regrettable drift back to London, and the teachers' own problems are among the topics studied. The return to London was already taking place before the inquiry could be initiated, yet even this fact was turned to account, for parallel inquiries were made in the London areas concerned in order to determine the causes of the partial failure of evacuation. That the picture presented is familiar in its outlines does not diminish the value of the book, for it is of the first importance that general impressions should be checked by careful research. Some popular opinions are shown to be based on exaggerations, as when it is found that the proportion of maladjustments in the foster homes is only about 8 per cent, not a high figure in the circumstances. An interesting point is the suggestion that such difficulties increase with the age of the children. In early adolescence problem situations are not unusual in the home, and the stresses of growing up into independent personalities are exacerbated when the child is placed with strangers, among whom the easy tolerance of the home is inevitably lacking.

A full year had been allowed for working out the scheme of evacuation, and the time was largely wasted. The difficulties were immense (and their scale can be seen more clearly now than before evacuation) but surely there could have been less 'trial and error' procedure. The actual movement of the child population was effected with efficiency, but too little thought had been given to the difficulties to be encountered in the reception areas, and the outstanding failure was in respect to psychology. A great deal is now known about children, and the accumulated experience of child guidance clinics is available to meet the problems arising from such a profound mental disturbance as that caused by separation from parents under the threat of air attack. If a mass movement was to be successful it had to be soundly based on the psychology of children and parents. This was neglected. It is clear, for example, that the responsible authorities either under-estimated the strength of parental affection, or over-estimated parental self-control. Insufficient regard was directed to the emotional unity of the family, and as little to its economic unity. A total family income cannot be considered as distributed at so much per head. Every working-class mother knows this: authority apparently did not. To take one point only, when the children of a family are scattered the normal 'handing down' of clothes becomes next to impossible, and a new expense is thrown upon the parents' limited resources.

Clinical psychologists are well acquainted with the emotional disturbances which originate in a sense of the insecurity which accompanies dependence. We have learned that the benefits of adoption into a thoroughly good home have to be balanced against the child's unhappy realization that others may dispose of him like a parcel of grocery, and that he is powerless to resist. This was the situation of the evacuated child, with the added terrors, whether real or imaginary, of the War. Difficulties from this source were unavoidable: they should have been expected, and measures taken to reduce their effects. Fortunately, the average child is a resilient creature, or evacuation would have been even less successful. The difficulties of the foster parent also might have been envisaged. What *is* the uninformed householder supposed to do when called upon to take charge of a border-line deficient ?

The authors are content to state the facts they found, with just a little censure, much praise, and no polemics. The book is an important contribution to the literature of psychology and sociology, and deserves high praise. The style is attractive, the argument cautious and restrained. Its value can be more than historical, for not only is evacuation a continuing problem, but there will also be subsequent questions of re-settlement of a similar kind. The nation is conducting its greatest sociological experiment and the book under review is an analysis of part of the data. Other studies would be welcome if carried through as well as this. Then will come the practical task of convincing the authorities that psychological principles must provide the bases of all attempts to handle human beings. There is as yet little evidence that they are willing to learn a lesson so inconvenient to routine administration.

A. W. WOLTERS.

CHEMICAL WARFARE

Chemical Warfare

By Curt Wachtel. Pp. ix+312. (London: Chapman and Hall, Ltd., 1941.) 24*s*. net.

DR. CURT WACHTEL organized the pharmacological section of the Kaiser Wilhelm Institute during the War of 1914–18. He was intimately concerned in the investigations which led to the very successful use of chemical weapons by the Germans, and has kept his notebooks, which contain descriptions of many experiments still unpublished. After the War, he studied the hazards due to toxic gases in peace-time in Germany, Russia and elsewhere. He now lives in the United States, and has written a book on chemical warfare which he hopes will help the military of his adopted country. The book was published in the United States by the Chemical Publishing Company and an English edition has now appeared.

Many aspects of chemical warfare are briefly discussed. The history of the subject from the time of the Pharaohs is reviewed. The circumstances which led to the development of chemical warfare in Germany during 1914–18 are described with interesting details about the personalities involved, and a picture is drawn of an ideally efficient institute for the advancement of knowledge in this field. The author does not hide his belief that German men of science are more gifted than those from other countries, and that Fritz Haber was the greatest of them all. He is fond of speculating on what might have happened had circumstances been different, and the main circumstance to which he attributes Germany's defeat is the selfishness of second-rate bureaucrats, who would not listen to their technical advisers. This theme recurs and tends to irritate the reader by spreading an atmosphere of grievance over the book. The author hopes to aid the unimaginative bureaucrats of to-day by putting ideas in their heads, but the ideas are only vaguely put forward, and must have occurred to anyone who has given serious thought to the matter. There is no evidence that it would be possible to put them into practice.

The results of a number of German investigations are now published for the first time, but without those corroborative details which alone can carry scientific conviction. Indeed, there are so many obvious minor errors that it is impossible to know whether any particular statement is reliable or not. Misprints, of which there are many, are easily detected when they only involve single letters, but apt to be confusing when, for example, it is said that cyanogen chloride is heavier than cyanogen chloride, or when the same formula is given for both phosgene and diphosgene. There are faults in the English, such as when "tearing" is used to denote the shedding of tears. Concentrations of gas are usually given in milligrams per cubic metre only, but on p. 195 they are also given in cubic millimetres per cubic metre, and the two sets of figures cannot both be correct. This fact casts doubt on the other figures in the book.

It is hoped that Dr. Wachtel will be able to give the scientific and military men of his adopted country more direct help than they will get by reading this book, which has too many facts for a popular book and too few for a scientific book.

CANADIAN NATURAL HISTORY

A Naturalist in Canada

By Dan McCowan. Pp. xii+284+20 plates. (Toronto: The Macmillan Company of Canada, Ltd., 1941.) 15*s*. net.

THE author of the book under review displays more than a speaking acquaintance with the natural history of both the Old and the New Worlds. Since his boyhood days in Scotland, Mr. McCowan has been an ardent student of Nature in the field, and his migration to Canada many years ago merely served to intensify his curiosity concerning the why and wherefore of all things animate and inanimate. He is no armchair naturalist.

A brief glance at the subject-index immediately serves to acquaint the reader with the diversity of the subjects discussed by the author, which are distributed through thirty-nine chapters and embrace such widely divergent topics as the preparation and uses of pemmican, the status of the oolachan or candle fish, the economic importance of the whitefish of Canada's inland lakes, the breeding and blood-sucking habits of the vexatious and persistent northern mosquitoes or "animated gimlets", the ways of eagles and other rapacious birds, and the secluded man-avoiding habits of the isolationist colonies of the white pelican. Other interesting chapters are devoted in whole or in part to the edibility of wild plants, the chorus of frogs which contributes in no small measure to the reality of the Canadian spring, and the habits and conservation of Canada's wild ungulates including the musk-ox, moose and Rocky Mountain goat as well as the reduced populations of the pronghorn antelope and buffalo, now protected in special reservations as wards of the Government of Canada.

No account of Canada's natural history resources would be complete without mention of the rich Dinosaur beds of the Red Deer River valley at Drumheller, Alberta, and the fossil rock libraries of the Rockies; so, due attention is paid to those in a special chapter entitled "The Record of the Rocks".

As for the plan of the book, the marked lack of an ordered sequence in the arrangement of the chapters is explained by the fact that each represents a separate and distinct unit prepared for presentation in a series of broadcasts to Canadian listeners. Thus the circumstances which inspired the book may serve to explain the double standard of diction employed by the author. At times, for the sake of expressiveness, the author does not despise the use of modern trite expressions, while at other times he proves himself equally facile in welding the beauty of words to the beautiful things of Nature. As an example of the former the reader is referred to p. 77, where the author, in stressing the importance of the house-fly, as a vector of disease conveys his meaning in the following words: "Many kinds of germs thumb a ride in the hairy coat of the fly and thus are enabled to make a happy landing in places where unscreened meat or other human food is exposed." As an example of the latter the reader is referred to the following passage on pp. 270–271: "The times may be out of joint and the world of men all awry, but in the woods and fields and on the lone moorlands the flowers and the bees contrive to work together harmoniously and in peace. They are not vexed by the rattle of sabres nor by the ceaseless clang of the armourer's anvil. Overhead are blue skies and white clouds, morning sunshine sparkles on the rippling lake and clear-running stream: the leafy trees cast a grateful shadow at noon. When evening falls there is dew on the meadows and a great hush in the green forest."

In these days of modern ecological methods where the behaviour of species is measured with a yard-stick, their reactions resolved in the columns of lengthy tables and reduced to graphical representation, it is refreshing to pick up a book in which the author, imbued with the sheer joy of his subject, looks at Nature clear and whole and not as so many separate pieces of a picture puzzle.

To those of us who have had the privilege of observing and studying Nature on both sides of the Atlantic, Mr. McCowan's book strikes a responsive chord and serves to recall many memorable days spent in collecting and research in the vast open spaces of the Canadian West, where often for company there was naught but the boom of the bittern among the reeds, the laughter of the loon on the lake, the bark of the coyote in the grove or the splash of the musk rat in the slough. Even solitude had its enchantment.

A. E. CAMERON.

Visibility in Meteorology

The Theory and Practice of the Measurement of the Visual Range. By W. E. Knowles Middleton. Second edition, completely revised and enlarged. Pp. x+165. (Toronto: University of Toronto Press; London: Oxford University Press, 1941.) 15*s*. 6*d*. net.

A SECOND edition of this book has been undertaken because of the large amount of work, both practical and theoretical, that has been done in the six years that have elapsed since the first edition appeared. This subject gains increasing importance as the rapidity of transport by sea, land and air continues to increase. The further developments of the subject in these six years appear to have induced a pessimistic outlook about it in the author, whose enthusiasm for the use of the visual range as a synoptic element, which in his opinion has been shared by no one else, appears to have evaporated at the same time that he has "abandoned the search for a rational scale of visual ranges". One of the aims of the researches that are reviewed in this book is, as is pointed out in the introduction, to quote again the author's words, "to separate the subjective from the objective aspects of the problem, the psychological from the physical, the accidents of what there is to look at from the meteorologically significant properties of the portion of the atmosphere through which we look". This aim the author keeps constantly before him in this book, as only in this way does there appear to be any chance of getting the subject simplified and clarified and set on a firm scientific basis, after which the development of standard instruments and the co-ordination of observational methods should soon follow.

E. V. NEWNHAM.

Spectra of Long-Period Variable Stars

(Astrophysical Monographs sponsored by the *Astrophysical Journal*.) By Paul W. Merrill. Pp. ix+107+7 plates. (Chicago: University of Chicago Press; Cambridge: At the University Press, 1940.) 15*s*. net.

OUR knowledge of long-period stellar variability is still so fragmentary that much of the available information is widely scattered throughout various periodicals, and many of the proposed hypotheses are without doubt destined to eventual rejection. At this stage such a monograph as this is doubly welcome, since the author presents and coordinates a wealth of observed facts regarding the spectra of these stars while carefully avoiding a too close identification of these facts with current theory. Valuable as photometric and spectrophotometric studies of these stars are, the most fruitful line of attack on the many problems they present is that of detailed spectrum analysis. Accordingly Dr. Merrill gives a general account of the lines and bands in characteristic spectra at maximum light, and goes on to trace their variation with phase. Afterwards he devotes a chapter to individual variables which have been made the subject of specially detailed investigation. Finally, he gives an admirable summary of the various hypotheses which have been advanced to account for the behaviour of these objects, and suggests the most fruitful lines of future research. Not the least valuable feature of the book is the series of seven plates in which the characteristics of the spectra are illustrated by excellently reproduced high-dispersion spectrograms.

Cine-Biology

By J. V. Durden, Mary Field and F. Percy Smith. (Pelican Books, A85.) Pp. 128+32 plates. (Harmondsworth, Middx.; New York: Penguin Books, Ltd., 1941.) 6*d*. net.

THIS little book is extraordinarily good value although written in popular rather than truly scientific vein. The trinity of authors of various training and callings have collaborated most successfully in producing a vivid and usually accurate account of the structure and life-histories of selected animals from Amœba up to and including the Insecta, and this account is well illustrated by numerous drawings and photographs. In spite of the title the last are, perhaps, less of a feature of the book than the 'photographic' clarity of most of the descriptions, which may accordingly be recommended to the youthful or would-be zoologist as well as to any intelligent layman. The whole is attractively and indeed charmingly written, with a minimum of technicalities and a useful glossary at the end; but the title is misleading in that only one prong from the fork of life is dealt with, and that is the one the very existence of which depends upon plants.

N. P.

This Physical World

A College Course in Science. By Prof. C. C. Clark, C. A. Johnson and Lt.-Comdr. L. M. Cockaday. Pp. x+528. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 22*s*. 6*d*.

AMERICA seems ahead of Great Britain in realizing the necessity of inculcating a nodding acquaintance of scientific method in those whose later activities in life are to be other than scientific or technical. The present volume is a re-written cultural course for those not pursuing science as a major subject. The result is a very attractive review of present-day scientific background, bringing home the benefits, and otherwise, of applied science and the fundamentals whence it springs. The first chapter properly outlines the scientific method, noting its historical growth and force in ascertaining the material truth of things, its demand for precision in measurement and integrity in interpretation. The review of basic knowledge and its consequences then ranges from contemplation of the heavens, the structure of matter, reactions among chemical elements, heat and heat-engines, waves, electrons, and modern electrical communications. The authors are out to impress the reader, with an easy, but accurate, style with the best possible illustrations, that science and its applications are mighty forces in our present civilization, and why not?

L. E. C. H.

GLACIATION AND SUBMARINE VALLEYS*

By PROF. REGINALD A. DALY
Harvard University

CONTINENTAL terraces are huge submerged benches, each surfaced by a continental shelf and a continental slope. The fall-off of shelf to slope begins not far from the 50-fathom isobath. The shelves vary in width from a few miles to 150 miles, their seaward gradient averaging about 1 in 1,500. The average gradient of the continental slope, measured from the fall-off to the flat plain of the deep ocean, is about 1 in 15, or 100 times as steep; measured from the fall-off to the 500 fathom isobath, the seaward gradient averages about 1 in 10, or 150 times as steep as that of the shelf.

Direct sampling shows the surface of the terrace to be underlain by loose, land-derived sediments, though exceptionally considerable patches of hard rock, without sedimentary cover, have been demonstrated.

With total length of 60,000 miles and average width of 100 miles, the terrace borders each of the big masses of land. Here we have that part of the sea floor which has liveliest interest for fisherman, navigator, and cable-layer, and therefore vitally relates to the practical life of civilized man. But the continental terrace has in addition a special scientific appeal, for its study has recently led to an astonishing discovery—the systematic ruggedness of its long outer slope.

It is already clear that the ruggedness is the result of dissection, intaglio carving, of the continental slopes by running water. The specific question is as to the nature of the eroding streams. Closely related is the question as to the time when the sculpturing took place.

Five years ago, I offered a hypothetical explanation of this mighty sculpturing of the continental terraces. Since then, new facts have been discovered and these seem to fortify the explanation. According to the preferred theory, the furrowing of the flanks of the continents was due to silty underflows—bottom currents of heavy water that rushed down the continental slopes, much as gushes of rain water 'gully' hillsides on the land. The water was heavy because laden with mud and sand in suspension, the mud and sand being made of rock particles which were two to three times as dense as clean sea water. The mud and sand were brought into suspension during the tumult of storm waves that broke on the shallows of the continental shelf, and during the rushes of the turbulent tides across the shelf. This weighted water crept slowly down the gently inclined shelf and then hurried down the much steeper continental slope. The velocity of these underflows is thought to have been so great that deep canyons and furrows were cut in the original sediments of the continental slope, and as many ridges were left between the new valleys.

Such trenching may be possible at the present time, especially where the zone of intense wave-action is only a short distance from the fall-off to the continental slope, but, according to the preferred theory, the furrowing of the slope was due to the special conditions of the Glacial Period, when there were drastic, world-wide migrations of the zone of breakers out to the edge of the continental shelf and back again.

Let us look first at the known facts and then at different hypotheses so far offered in explanation.

Observations of Submarine Valleys

Early in the latter half of the nineteenth century, it was shown that the generally smooth surfaces of the continental shelves flanking North America, Europe, and Africa are interrupted by trenches or 'channels', each of which begins a few miles from the shore and continues in a fairly straight line across the shelf, all the way to the fall-off where the continental slope begins, about 300 ft. below sea-level. At the fall-off the 'channel' merges into a 'canyon' cut in the continental slope. Here the widths of the valley-like trenches are measurable in miles, while their floors lie thousands of feet below the general surface of the continental slope. An example is the Hudson canyon, continuing the Hudson 'channel', which crosses the shelf and is itself *en axe* with the Hudson River at New York City. A few years of echo or sonic sounding increased the number of known canyons from a half-dozen to more than one hundred. This is already a large number, though less than one per cent of the total 'longshore length of shelf and slope has been adequately sounded.

Off a 400-mile stretch of the coast of the eastern United States, more than a score of canyons, or one for an average interval of 15–20 miles, have been mapped. But the wonder of their disclosure grew with the simultaneous discovery of deep and general trenching of the areas separated by the canyons. There the trenches, greatly outnumbering the canyons, differ from them by heading at or below the fall-off at the head of the continental slope. To distinguish these many, somewhat shorter valleys, we shall call them 'slope furrows', or simply 'furrows'. Between each pair of adjacent furrows is a long strip of higher ground; each strip may be called an 'inter-furrow ridge' or simply 'ridge'. Like the furrows and canyons, the ridges run in the general direction of the continental slope, that is, approximately at right angles to the line of fall-off or break of slope of the continental terrace.

The first maps well illustrating the association of canyon, furrow and ridge were made by the United States Coast and Geodetic Survey. From the soundings of 1930–32 the region of Georges Bank was mapped by Lieut. P. A. Smith. Although the soundings were numerous, they were too few to permit unequivocal contouring. Similar failure to portray the submarine relief with complete objectivity and exactness must characterize all other published maps of the kind, especially when depths exceed 1,000 fathoms. Nevertheless, it can scarcely be doubted that in principle all the Coast Survey maps, inside the 1,000-fathom line, give a good picture of the relief.

The next four seasons of exploration covered in large part the continental shelf and slope along the belt from Long Island to a point off Norfolk, Virginia. From the soundings three isobathic maps were drawn by the late A. C. Veatch. This belt, 250 miles long, includes five principal canyons, all heading far back in the continental shelf. To suggest their relative positions, they have been named, in order from north-north-east to south-south-west, the Hudson, Wilmington, Baltimore, Washington and Norfolk Canyons.

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* From a paper read at the Fiftieth Anniversary Symposium of the University of Chicago on September 25.

The Hudson Canyon is continuous with the Hudson Channel across the shelf. There is no similarly clear relation for any of the other four canyons, though traces of what appear to be true shelf channels appear to east and west of Cape May. It is possible that some of the more southerly canyons are genetically connected with the Delaware and Susquehanna River systems, thus recalling the more direct correlation of the Hudson River, Hudson Channel and Hudson Canyon. On the other hand, it is worth noting at once that none of the canyons of Georges Bank has any obvious or probable relation to rivers of the continent.

The side slopes of submarine canyons are variable but comparatively steep. Along the upper and deeper parts of these valleys, as mapped by Smith and Veatch, the side slopes range from 1 in 3 to 1 in 5 and average about 15° from the horizontal. This is about the angle of rest for soft sediments.

The whole topographic pattern is on a scale nowhere matched on the land, where, however, there are small-scale analogies. Among these are the gullied slopes of many railway cuts. Illustrations are found where the initially smooth sides of the cuttings have exposed weak material, and that so long ago that gushes of rain water have had time to gully the artificial slopes. Particularly fine examples are to be seen along hundreds of miles of railway traversing the southern Appalachians. Another analogy, of more generous dimensions, is the system of rain gullies eroded out of soft Californian formations. At the railway cutting an occasional gully is more deeply incised than the average gully and also heads far back of the break of the slope at the limit of higher ground alongside the cutting. Such an exceptional gully corresponds to the typical submarine canyon.

As yet, soundings in belts other than those around the United States have not been detailed enough to show how general is the furrowing of continental flanks the world over. On the other hand, the more easily discovered canyons are reported off five continents and in the three principal oceans, and it is highly probable that each region with canyons is also intensely furrowed. The distribution of the canyons is world-wide—a fact of great importance for any theory of origin for the great valleys.

From their general similarities we may well assume that at least the majority of the canyons, the world over, were simultaneously developed; and their form seems clearly to imply that they are youthful features of the submarine topography.

Where mapped in detail, the canyons and furrows seem to differ significantly from the Grand Canyon of Arizona and similarly walled, sub-aerial valleys. Although cases of similar variation of side slopes may be ultimately found in the submarine valleys, no systematic alternation of cliff and talus is shown by any of the isobathic maps now published. These last suggest that the layered rocks composing the great continental terraces are, with respect to strength, relatively homogeneous.

A strong indication that in general the sediments offer little resistance to erosion by bottom currents has been supplied by the seismographs of Ewing and Bullard, who have recently reported great thickness for unconsolidated and semi-consolidated phases of the American and European terraces. A similar story is told at the deep borings off the Louisiana-Texas coast. All these determinations are obviously favourable to the preferred glacial-control theory of canyon and furrow.

Another significant set of facts: with a dredge Dr. H. C. Stetson found the canyon walls to include two horizons of sedimentary rock containing Foraminifera. Dr. Cushman refers one horizon to the Miocene and regards the other as probably Pliocene. Thus we have an upper, probably Pliocene limit, for the age of the canyon-cutting. Stetson has also shown that the canyon floor is now being raised by the deposition of fine mud, already a few inches or feet in thickness; and that this muddy layer is underlain by other sediment containing the shells of cold-water marine animals of types expected in these latitudes during a glacial stage of the Pleistocene. The stratigraphy suggests that the valleys concerned were excavated in pre-Wisconsin time, though not necessarily in pre-Glacial time.

Submarine Erosion

Opinion has come to favour submarine erosion as the cause of canyon and furrow. On this basis three contrasted hypotheses have been proposed. Respectively they emphasize principles symbolized by the phrases 'spring-sapping', 'earthquake wave', and 'silty underflow'.

Prof. D. W. Johnson has elaborated the spring-sapping hypothesis. Analogy with the headward growth of valleys in the high plateaux of the south-western United States is emphasized. The plateaux are underlain by alternating beds of porous and tight, permeable and impermeable, rock. The rain water fallen on the high parts of one of these land plateaux sinks to one of the continuous permeable beds, along which the water creeps, down to a lower level where the bed, or aquifer, crops out. Here the subterranean stream issues with some kinetic energy and also with power to dissolve rock matter. Here the relatively weak, porous rock is eroded away, whereby the overlying stronger beds of rock are undermined. Ultimately the undermined rock is torn apart by gravity, with sliding of great blocks into the new part of the gulch. The debris of the slides is further broken up by frost and other weathering agents, and, both in solution and by mechanical washing, is carried away. Thus the new valley is gradually lengthened by 'spring sapping'.

Johnson suggests that the submarine valleys have been lengthened in a similar way. His speculation is based on a number of assumptions: (*a*) each continental terrace includes an adequate number of continuous aquifers; (*b*) these aquifers crop out on the continental slope at the appropriate levels; (*c*) the flow of the ground-water along the aquifers has sufficed to produce trenches of great length and great depth below their respective rims; and (*d*) the removal of slumped rock-debris at each valley-head has been due to solution in the aquifer water. All four assumptions may well be doubted.

While here and there permeable beds have been demonstrated in the continental terraces, we have no evidence that they are abundant enough or continuous enough to match the number of submarine valleys already discovered. Then, too, it is highly improbable that there can be aquifers outcropping near the fall-off to the continental slope, in number sufficient to explain the heading of so many furrows at the line of fall-off. Thirdly, it is clear that most of the canyons are found in regions where both topography and geological structure forbid belief that the fresh water in any aquifer can have a hydraulic head which is adequate to overcome the back pressure of the denser sea water. Examples are seen in the canyoned belts off Georges Bank, off India, off California, and off the west coast of Africa. In my opinion, the same is true in the case of the belt off the eastern United States. In the fourth place, it is a question whether the issuing aquifer water would not be largely saturated with rock matter dissolved from the porous bed itself and to that extent incapable of dissolving rock debris in the hypothetical new gulch. If the issuing water is not saturated, it is likely to be less dense than the sea water, in which it must rise and thus lose contact with the rock debris entirely. Evidently solution of the slumped debris would be out of the question. A final and likewise telling objection: the spring-sapping hypothesis postulates important solution of one of the least soluble materials known to geology—clay. With that premise neither geologist nor geochemist is easily satisfied.

The second hypothesis which is based on the postulate of a submarine origin is that of Prof. W. H. Bucher, who attributes canyon and furrow primarily to cutting by reflux currents associated with powerful earthquake waves in the ocean. But here, too, there are troubles. That part of the energy which belongs to the reflux current is largely concentrated near the surface of the ocean, the velocity of the motion decreasing with great rapidity as the depth of water increases. The laws of hydraulics demand that even the mightiest seismic wave cannot give a reflux current fast enough to erode the lower half of the continental slope, down which, nevertheless, the submarine valleys continue for many miles. Further, the earthquake waves run in packs, as so-called trains of waves, but no train of waves attacks a coast for more than an hour or so, and none attacks it more than once in a stretch of time measurable in decades or centuries. In fact, no major earthquake wave has ever been recorded in the North Atlantic, where submarine valleys are in full development. The possibility that in prehistoric time this ocean was long shocked much more vigorously than at present is emphasized by Bucher, but only in a purely speculative way and without proof. Similarly there is no evidence that such reflux currents have been powerful and numerous enough to account for the valleys sunk in the continental terraces of the Indian Ocean or the eastern Pacific, from Vancouver to southern California.

Influence of Glacial Control

The third explanation based on the assumption of submarine erosion adopts the idea of glacial control and, in my opinion, is by long odds the most satisfying of all the published attempts to account for these submarine valleys.

About 40,000 years ago, the last set of Pleistocene ice-caps of North America and Europe were of maximum total volume, but were just beginning to melt away. With the exception of a few small patches, the last remnants of the gigantic masses of ice had disappeared by the year 7000 B.C. Since the water of the ice-caps had been evaporated from the ocean and then dropped, as snow and rime, on the lands, the sea-level was lowered all around the globe. The lowering was about 300 ft. in maximum.

From the amount of work done by the last set of ice-caps, it appears that sea-level was nearly as low during a period of the order of 50,000 years. During three long intervals of still earlier Pleistocene time, ice-caps had slowly grown to comparable size and then melted away more or less completely. The second glaciation seems to have been more extensive than the last one, and may be thought to have lowered sea-level a little more than 300 ft. During tens of millennia each set had maximum total volume; and during still other tens of millennia each set was slowly melting. From beginning to end of each of the four glacial stages—chaptered as growth, culmination and waning—the wind waves and tidal waves were breaking on the continental shelves, far out from the existing shore lines. Thus, for a time totalling more than a quarter of a million years, the waves were pounding the old embankments of clay, mud and sand. Along the temporary, slowly migrating shores, storm wave and turbulent tide were muddied to a degree far beyond that represented in the 'longshore water of the present day. While so charged with particles of solid rock, the silty water was effectively denser than clean sea water, and as a temporary suspension, sank bodily to the bottom, that is, to the surface of the continental terrace. There the specially weighted water flowed slowly down the gently sloping continental shelf, to run much faster after it had passed the fall-off at the top of the continental slope. Such accelerated density currents along the sea floor were, according to the hypothesis now to be discussed, the chief excavators of our submarine valleys.

The compulsion on silt-laden water to dive and slide along the sea bottom was, of course, lessened in proportion to any settling-out of solid particles. However, such loss of excess density took time. Observation shows that shore waters, agitated by a storm, remain murky with sediment for many hours after the storm has spent its fury. We may therefore assume that a bottom current of Pleistocene time could run many hours. Over the gently sloping shelf its velocity was comparatively small, and over this region some of the coarser detritus must have settled out. But, according to the hypothesis, the zone of agitating waves was long situated at, or close to, the fall-off to the continental slope. Without delay the silty water would be precipitated down the continental slope, and that with a velocity much greater than any possible on the adjacent shelf. With only moderate velocity the silty current would cross the whole slope in some hours. If, during those hours, the speed were enough to cause turbulent erosion of the slope sediment, the settling-out would be delayed and new solid particles added to the soup-like suspension. Nowadays the zone of intense agitation by the breakers is 50–150 miles from the outer edge of the flat shelf; hence now, during the long, slow journey to the fall-off, a bottom current loses much of its operating load by settling out and therefore cannot attain great speed down the continental slope. Is it not clear that the silty currents of each Glacial stage should have been incomparably more energetic on the slope than any current developed by storms in post-Glacial time?

Quantitative Tests

Quantitative testing of this glacial-control hypothesis presents some difficulty. Essential facts are buried in both space and time—under the ocean and under the obscuring blanket of post-glacial and glacial time. Yet there are already in sight valuable tests, which, taken together, greatly encourage faith in the root idea as the most promising of all those reported in print. These tests are based on illuminating analogies in Nature, on laboratory experiments, and on an engineer's formula relating to the flow of liquids under gravity.

An obvious analogy is that of the ordinary river, which also flows along the bottom of an ocean—an ocean of air. One condition for its descent is its possession of density greater than the density of the covering air. Similarly, the silty submarine current runs down the continental slope because the density of the mud-charged water is greater than the density of the covering clean water.

More than half a century ago Forel studied the behaviour of the Rhone where its water, made milky with suspended rock-flour that was brought from the high glaciers of the Alps, enters Lake Geneva. Any summer visitor on the heights above Montreux can see the whitish, silt-laden water of the river deployed on the lake for some distance. He can see that this water is sharply bounded against the blue water of the lake. With simple apparatus Forel proved the sharpness of contact to be due to an almost vertical plunge of the silty water to the bottom of the lake. He thus showed that the silty current does preserve its individuality under the lake water. But to what distance ? Forel found the answer to this query also. He noted that the sub-lacustrine delta of the Rhone is interrupted by a channel-like furrow, extending six miles down the delta, measured from the point where the silty water makes its initial plunge. This point is just outside the jetties at the mouth of the Rhone. The depth of the channel below its rim is considerable, with maximum of nearly 200 ft. Forel imagined two possibilities: first, that the channel has been dug by the bottom current; second, that the channel is the result of preferential deposition of the silt where the bottom current loses velocity by friction against the stagnant lake water on either side of the current. The latter process would be analogous to the levee-building along the lower Mississippi River. Forel ultimately found more satisfaction with the second explanation of the channel. On the other hand, a much later study led Dr. Romieux of the University of Geneva to favour the erosion hypothesis. But, whether erosion or differential silting of the lake floor, or a combination of the two processes, be the true mode of origin, it is clear that the Swiss limnologists believe in the persistence of the bottom current to a distance of six miles. Their conclusion deserves strong emphasis in the discussion of submarine valleys.

Switzerland has a parallel case. The contoured map of the Rhine delta under the surface of Lake Constance portrays a trench across the delta with dimensions much like those of the Lake Geneva channel. Be it noted, too, that each of the Swiss channels has a slope which is less than one two-hundredth of the average slope down the flank of a continent.

For our problem, analogy becomes still more illuminating when we watch the course of a muddy river that enters a long reservoir, created by an artificial dam at the opposite end. An ideal case is represented where the Colorado River penetrates Mead Lake, a reservoir with a length of about 120 miles, measured from the celebrated Boulder Dam that holds up the water level. Since progressive silting and shallowing of the reservoir are inevitable, Government engineers are systematically measuring the proportion of solid matter suspended in the water at the intake, and as systematically tracing the course of this weighted water after entry into the reservoir. Cloud-bursts upstream from the lake suddenly increase the volume, velocity and silt-content of the torrential river. At the intake, the point where the muddy Colorado enters the reservoir, the time of arrival of water with maximum muddiness is noted. Some days thereafter the same water, still charged with an extra load of suspended silt, appears at the penstocks of the dam, now 120 miles below the intake. That the muddy current hugs the sloping bottom of the lake has been proved by sampling the water from surface to bottom and at various vertical sections between intake and dam.

Above each muddy sheet the reservoir water, hundreds of feet thick, was almost entirely free from suspended particles of rock. Here, then, we have another proof that a silty current does not lose its individuality by mixing with the overlying clear water or by the settling-out of the silt. In the case of Lake Mead the bottom current persists for as much as 150 hours, one of the measured times for the traverse of 100 miles in the lake.

By identifying individual influxes of muddy water, engineers have been able to measure the average velocity of the current between intake and dam. In one instance the rate was found to be about half a mile per hour—a notable speed for a current following the average gradient of the floor of the reservoir, namely, a gradient of only 7 in 10,000 or less than 1 in 1,000.

The Elephant Butte Reservoir, in the Rio Grande valley, receives the inflow of the Puerco River, which in flood is charged with fine sand and mud to an extraordinary degree. Here too the muddy water is seen to dive along a sharp line of demarcation at the surface and then follow the gently sloping bottom of the reservoir to the retaining dam, the surface water remaining "perfectly clear". The sub-lacustrine journey is about 35 miles in length. Although the measured thickness of the silty current is comparatively small—only five feet in one reported case—and, although the bottom gradient averages only 1 to 1,000, the velocity of the bottom current has registered as much as 1·5 miles per hour. The high speed is explained by the unusual muddiness of the Puerco River at time of flood. After the entry of its water into the reservoir, a cubic foot of this water weighs two to three pounds more than a cubic foot of clear water at the same temperature.

Bottom currents, similarly motivated by suspended silt, have been demonstrated in four other American reservoirs—Lake Lee (North Carolina), Lake Murray and Saluda Reservoir (South Carolina) and San Carlos Reservoir (Arizona). The Government engineers have thus good ground for the conclusion that underflow of the kind described is a "general phenomenon in reservoirs" subject to inflow of muddy water on the grand scale. The silty water slides down the floor of a reservoir "much as water itself flows under air".

Small-Scale Tests

The studies at Lake Geneva, Lake Constance and the six artificial lakes in the United States have established two fundamental facts: first, a silty underflow persists, with much of its initial velocity, for many hours and even as much as seven days; second, the speed of flow can exceed one mile an hour although the slope traversed is only 1 to 1,000, and although the thickness of the bottom current is only a few feet. Since the continental slope is about 1 in 15, and since the thickness of the silty current of glacial times must have been at least 100 ft. and probably more, we already have, from analogies in Nature, some good quantitative support for the preferred explanation of the submarine canyons and furrows. But other quantitative criteria as to the worth of the explanation should be found if properly controlled experiments are made in the laboratory. Knowing that experiment is the principal tool of science, Dr. P. H. Kuenen, of Holland, has called on the resources of the laboratory. He had three objectives: to devise a visual test of the possibility that silty currents can long preserve their individuality, even though the motivating silt tends to settle out; second, to measure the velocities under controlled conditions regarding current density and slope of channel; and, third, to determine whether a current, flowing fast, will add to the suspended load and therefore run still faster. Kuenen succeeded with all three problems, and not the least significant of his conclusions is that a strong bottom current running down a continental slope may readily become self-accelerating and thus endowed with new self-generated power to erode. Some of his experiments will be briefly described.

In a glass-walled tank, 15 ft. long and 2 ft. deep, a model of a 'continental terrace' was built of sand surfaced with hard gypsum. The 'shelf' had a gentle slope as far as the fall-off of the 'continental slope', which had a gradient of about 1 in 7, or one typical of the upper part of the average continental slope in Nature. Water was poured into the tank until it topped the 'shelf' by a few millimetres or centimetres. Just above the fall-off a strip of wood with a rubber flange at the bottom was placed across the tank. Behind this bar, water with various proportions of solid particles in suspension was gently poured on the 'shelf'. The bar was then removed. The silty water at once began to flow down the 'continental slope' in the form of a lively current.

It was found that any slight crease or depression directed down the 'continental slope' tended to draw the silty water from right and left, thickening the current and correspondingly increasing its velocity. A tongue of the silty water ran down ahead of the more slowly flowing suspension on each side of the tongue.

Similar suspensions were released after the hard surface of the model was covered with thin layers of clay. When only moderately charged with 'silt', the density current became turbulent soon after passing the fall-off. With the onset of turbulence the current began to deepen the initial depression directed down the 'continental slope', making this into a 'canyon' or 'furrow'. With the erosion went a gain in load for the current and also measurable acceleration of its velocity. Thus Kuenen proved once more that "to him that hath shall be given".

In order to make more vivid the evidence for erosion and self-acceleration of current, both to the eye and the camera, clear solutions of salt in water were released on the 'shelf', this time covered with a thin layer of white mud.

Kuenen measured the velocities of flow and was able to estimate the average thicknesses of the moving sheets of 'heavy' water, as seen through the glass walls of the tank. Knowing also the slope of the bottom, he had the data for applying an engineer's formula, which, with proper precautions, can be used to calculate the velocity expected for a current flowing steadily down a continental slope. This formula is $v = c\sqrt{m.s.d}$, where c is a constant, v represents the velocity, m is the so-called hydraulic mean depth (the cross-section of the current divided by its wetted perimeter), s the slope, and d the effective density of the flowing material.

From the measured values of v, m, s, and d in the case of a bottom current at Lake Mead, Dr. Kuenen deduced an approximate value for c that would match the conditions for erosive furrowing of the continental slope. In the centimetre-gram-second system of units, the value for c came out at 400. For our problem let us assume m to be 5,000 cm.; s to be 1/15; and d to be only 0·0005. With corresponding substitutions in the formula, the velocity is found to be about 160 cm. per second or 5·75 km per hour or 4 miles per hour—a velocity sufficient to move coarse gravel and to tear up silt and sand. Silty currents set running by major storms in glacial times must have had initial effective densities higher than 0·0005; nowadays wave-stirred, silty waters have measured densities twice as great.

Dr. Kuenen's experiments are particularly eloquent in showing that, if the current, running down the muddy continental slope, reaches a velocity of only two miles an hour, it should take up a new, additional supply of mud and should, therefore, run all the faster and erode still more efficiently. This new power would, of course, be lost again when the current reached the lower, flatter part of the continental slope. Kuenen's own graphic statement may be quoted: "The part played by the shelf is now thought to be that of the ringing voice loosening an avalanche. If the density of a comparatively small volume of water is once raised above that of the deeper strata, the flow is set off. It gathers volume and speed on the way down and takes up more and more silt. Given a little help the canyon erodes itself." This conclusion is all the more acceptable when it is remembered that the terrace sediments are water-soaked, hence highly mobile, and deposited near the angle of rest. Such material at the angle of rest will yield readily if its back is even gently brushed by a downhill current.

Conclusion

Looking back, we see that the preferred, glacial-control explanation of canyons and furrows covers the essential facts, which may be listed as follows: (1) the comparative youth of the topography; (2) its world-wide, planetary distribution; (3) the similarity of the continental slopes to the gullied hill-sides on land; (4) the evidence that canyons are now being slowly filled with mud; and (5) the discovery of cold-water shells (foraminifera) in the clay that underlies the new muddy layer of incipient filling. Incidentally, the study of silty currents has indicated a mechanism for the transport of shore sediment to water depths of 2,000 fathoms and as far as 100–200 miles from the land where the sediment had been manufactured. This long travel of sand and mud has long been a puzzle. The silty-current hypothesis is favoured by the weakness of the terrace material, by the steepness of the continental slope, by the visible proof that shore waters are muddied through agitation by storms and tides, by laboratory tests, by the teaching of Nature in the Swiss lakes and in artificial reservoirs, and by the failure of all other hypotheses yet offered to account for the submarine valleys.

THE TEACHING OF SCIENCE

AT the Conference on Science and the War Effort arranged in London recently by the Association of Scientific Workers, there were two sessions devoted to the university training of scientific workers and the training of technical personnel. These sessions, which were attended by well over a hundred people, were remarkable for the wide range of teaching activity represented among both speakers and audience. Nearly every sphere of science teaching was represented, and the speeches dealt with ordinary university and polytechnic courses, the training of State bursars, the part-time teaching of young people in factories and workshops and the special training of recruits and cadets for the Forces. The limitation of time made it impossible to discuss at any length the teaching of science in secondary schools, but it was realized that the problem of scientific education must be tackled as a whole and that the school part of this is of fundamental importance.

Many of the questions discussed were not new, but the present war situation has brought all the old questions sharply to the fore along with some new problems. At the opening of the session on technical education, Mr. E. G. Savage, education officer to the L.C.C., who presided, said that the importance of technical education and the training of technical personnel needs no emphasis at this moment. As we are already bitterly aware, we are engaged in a war in which the quantity and quality of technical personnel is of the highest possible importance. Had we been better prepared in this matter at the outset of the War, it is possible that in at least one field of operations there might have been a different story to tell. As it is, we have been busily engaged in making up very substantial leeway. It is, however, equally important and very relevant to point out that the necessity for trained technical personnel will not diminish when peace comes. Mr. J. M. Keynes was recently quoted as saying that there is no necessity for us to be poorer for very long after the War. Given a proper use of the material resources of the earth and of the skill of our people, we should look forward to an even higher standard of living after the War than before it. To realize this happy issue, however, it is obvious that we shall need much more widespread and much more efficiently trained scientific and technical personnel in our industries and elsewhere.

Mr. J. A. Lauwerys, of the Institute of Education, University of London, said that we lack technically trained people because our secondary education, based on the study of language and literature, is out of touch with the requirements of an industrial society. The traditions which we inherited from ancient slave societies still dominate many of those in charge of our education. They still believe that the studies of highest educative value are those which have nothing to do with the production of useful commodities, and we are suffering from the widespread acceptance of the wrong view that 'culture' and 'vocation' should be kept separate. The question of elementary technical education involves several problems, but the core of the education we need must be scientific studies and not purely literary ones. That is not to say that we should support the proposals of the reactionary and outdated Spens Report with its deplorable suggestions that there should be grammar schools for future administrators, business men, etc., and technical high-schools for future skilled workers. To accept this would be to deepen the existing cleavage, the evil results of which have been and still are plain to everybody.

Dr. E. A. Rudge, of the West Ham Municipal College, said that the present difficulties in the supply of scientifically and technically trained people can only be met by the reorganization of schemes of education. This branch of teaching has been neglected over the past twenty years, and the salvaging of technical education should be regarded as a major part of the war effort. The necessary reorganization should be on a national basis, and the scope of local government control should be strictly limited. The raising of the school leaving age is necessary, and this would involve the abolition of fees for full-time students proceeding to technical vocational training. The scientific and teaching professions should recognize the inadequacy of present makeshift methods of selection and training, and must plan long-term and carefully organized schemes of education. He urged that we should strive for the setting up of a national advisory committee, including representatives of the scientific and teaching professions, of industry and of the Board of Education.

The important question of part-time training was discussed, and it was generally felt that the scope of this should be much extended. But this part-time education must be closely linked to the actual work being done in the factory or workshop, because most young people learn better when they feel that the subject is important and see its relevance. Although the better employers have for a long time allowed boys to attend part-time courses during working hours, this practice is by no means universal. The Essential Works Order requires firms to provide facilities for technical training, and if this were interpreted to include attendance at technical classes, inside or outside the factory, during working hours, there would be a considerable gain in technical efficiency. It would be desirable to start a sort of tutorial system whereby specially selected men co-operate with the educational authorities in the training of young people.

In this connexion the very important question of vocational guidance was raised. It was felt to be very desirable that there should be a great extension and systematic use of vocational guidance aimed at leading pupils fitted by capacity and inclination into well-designed courses of industrial training. The provision of such guidance on a large scale is a big problem, and it involves other problems such as how to make employers rely on the scheme and how to make it easier for young people who are misfits to change their jobs.

In the discussion on part-time training an important point in connexion with university and hospital laboratories was raised by Mr. B. E. Gilbey. The technical workers in pathological and bacteriological laboratories have developed, largely by their own efforts, into highly trained technologists. Their training extends over five years and is extremely haphazard, depending largely on the good-will of the senior members of the staff, so that they have to have recourse to evening classes which are often unsuitable. The unorganized training and the lack of professional recognition is resulting in the loss to an important profession of a large number of potential technologists at a time when they are urgently needed.

The inadequacy of the scheme of scientific education in the schools of Great Britain has been strongly underlined by the difficulties facing those who have to train technical personnel in the Services, and these difficulties were discussed at the sessions. There is a shortage of scientific knowledge throughout every grade: there are too few people with degrees, too few with higher school certificate science, too few with matriculation science and too many with no scientific background at all. Scientific weapons and devices have been perfected far more rapidly than people have been trained to use them, and so the limit of efficiency and success is in many cases set by personnel and not by technical advance. Although much has been done recently in many secondary schools, most private schools give little education in science, and the percentage of girls in the Auxiliary Forces with scientific knowledge is very small.

The present situation has vindicated completely those who have fought for the lengthening of the school period and for more science teaching. The need to-day is not only for a wider knowledge of the laws of physics and chemistry, but also for a more scientific attitude to all problems. To take only a few instances, there is a need for the Forces to have more understanding of the usefulness of controlled experiments, of statistical analysis of results, and of scientific tests for the selection of personnel. In some directions the work is good, and this is particularly so where civilian scientific sections responsible for the initial inventions have been asked to help in training. Members of these have the special task of following the new apparatus into operational use, and they have both advised on and taken an active part in the instruction of suitable personnel. In many cases, however, the training covers too narrow a field and is carried out without any regard for educational principles. There are many cases of people being taught to perform some process without being given any idea of where it fits in or even of why they are doing it.

It is quite clear that there is a great need for more technical officers in the Forces who have some training in educational methods, and for people with such training to join the civilian sections. On the other hand, it is vitally necessary that the military authorities should make the fullest use of those members of the Forces who have been trained in technical subjects or in educational methods. In the selection of personnel some sections make good use of psychological tests, but in others deportment, type of school, accent and pure chance still play a large part. This is to be deplored, though in this sphere, as in so many others, the continued efforts of those who are alive to the situation have produced good effects; but much remains to be done.

The session on the university training of scientific workers was presided over by Dr. W. A. Wooster, of the University of Cambridge, and the opening address was by Prof. J. A. Carroll, of the University of Aberdeen. Prof. Carroll stressed the need in modern civilization for a much wider scientific education in addition to the training of the specialist. University science teaching must abandon its present relative isolation and relate itself to its sources, the schools, and to its ends, the production of future teachers, of research workers and of people with a general education. The majority of students do not become research workers, so for the majority the courses are too detailed and too long. We need three types of university science courses: general honours courses for those who are going to teach in schools; special research and technical courses; and general cultural courses for those who intend neither to teach nor to do research.

As regards the supply of young people for university science courses, it is clear that the conditions of entry into British universities require modification. The development of junior, secondary and technical schools might prove very dangerous, because it might easily happen that pupils from these would be cut off from universities under the present conditions of entry. Prof. Carroll stressed the point that the reform of the educational system of Great Britain is long overdue, and that we are paying dearly to-day for the lack of common appreciation of the part which science could play in improving the conditions of life of the community. He also urged the setting up of an advisory committee on scientific education to advise the Board of Education.

The special effects of the war on the problems facing university science teachers were dealt with Mr. R. T. Lattey, acting director of the Electrical Laboratory, Oxford. He spoke of the present teaching of physics there, where four types of students have to be considered—more or less normal undergraduates, State radio bursars, Royal Corps of Signals cadets, and R.A.F. cadets. The most difficult part of the work is to instil a scientific outlook into immature minds, as most of the students have the idea that learning by rote is the end of all knowledge. The bursars come from all types of schools and the qualifications for bursarship as drafted are well below scholarship standard. The scheme can, therefore, be looked on as an interesting experiment of sending to a university pupils who would not get a scholarship in normal times. These students have turned out to be better than might have been expected, and it is clear that the average student has a considerable latent scientific interest and capacity.

Dr. V. E. Cosslett, of the University of Oxford, urged that as an immediate measure there should be proper organization and allocation of available laboratories and the depleted numbers of teaching staff. Very little has been done in the grouping of teachers and courses. Such steps are urgently demanded, for example, in the case of evacuated colleges, and it is certainly true to say that the best possible use is not being made of the limited number of teachers remaining in the universities and colleges.

The sessions on scientific and technical education were very successful in opening up the whole question, and in providing a broad view of the numerous problems involved. Among the speakers and those who took part in the discussion there was unanimous agreement on all the principal issues. The Association of Scientific Workers has begun to form a committee charged with the task of co-ordinating the experience and efforts of all those who are attempting to increase the quantity and improve the quality of scientifically and technically trained people in Great Britain. This is an effort which must succeed if we are to win the War with a minimum of loss, and if we are not to fall hopelessly behind certain other nations in the period of rebuilding after it.

We welcome the decision of the Association to form this committee and hope that it will develop a broad and comprehensive point of view, thus dealing effectively with science teaching in *all* educational institutions, for faulty education can obviously pass from teacher to taught, or from university to school, and vice versa.

OBITUARIES

The Earl of Berkeley, F.R.S.

RANDALL THOMAS MOWBRAY BERKELEY, eighth Earl, was born on January 31, 1865, and died on January 15. He was head of the historic house which acquired the Berkeley lands in the twelfth century, and is among the very few that can rightly claim a pre-Conquest pedigree ; even the critical genealogist Horace Round allows the Berkeley descent from Eadnoth the Staller, an officer of the household of Edward the Confessor.

In feudal days the Castle of Berkeley was held directly of the King, so that its owner was a baron by tenure, a status which in 1421 was merged in a summons by writ and a hereditary peerage. Since such baronies can be held and transmitted by females, on the death of the sixth Earl in 1882 it passed to his niece, wife of General Milman, who thus became Baroness Berkeley, while the earldom, created in 1679, went to a cousin as heir-male. For some seventy years this title had not been assumed, while there was doubt about its inheritance, leading to a famous lawsuit. Meanwhile the lands were in possession of the Lords Fitz-Hardinge. But in 1891 Randall Berkeley established his claim to the earldom before the Committee of Privileges.

Lord Berkeley began his active career in the Royal Navy and reached the rank of lieutenant. But being drawn to scientific research, he left the Service and built a laboratory at Foxcombe, on Boar's Hill near Oxford, a house which he much enlarged, adding a really fine stone hall. It is now the Theological College known as Ripon Hall. There he carried out his experiments, the success of which was shown by his election to the Royal Society in 1908.

Berkeley's work centred around the idea of measuring the physical properties of concentrated solutions, in order to test the possibility of applying to them equations of the type of that used by van der Waals for gases, vapours and liquids. The fundamental determination required is obviously that of osmotic pressure, either measured directly, or deduced by the principles of thermodynamics from the measured vapour pressures. To obtain accuracy in the results, many and great experimental difficulties had to be overcome. The original method of directly measuring osmotic pressure, invented by Pfeffer, is quite unsuitable when concentrated solutions are used. Instead of allowing solvent to enter a porous porcelain cell closed by a semipermeable membrane of copper ferrocyanide until equilibrium is obtained, Berkeley and his colleague E. G. J. Hartley deposited the membrane in the walls of a porous tube with its ends sealed, and varied the hydrostatic pressure on the solution until no further movement, either in or out, occurred. From 1904 until 1919 a series of papers, most of them in the *Proceedings* or *Transactions of the Royal Society*, appeared from the Foxcombe laboratory, gradually improving the methods and results, and dealing with other allied subjects, such as the vapour pressures and densities of solutions of varying temperature and concentration. The results of the measurements on bodies like sugars were shown to conform with equations such as

$$\left(\frac{A}{v} - p + \frac{a}{v^2}\right)(v - b) = RT.$$

Berkeley had an instinctive grasp of the methods of science and, moreover, had the skill, thoroughness and patience to apply them to his complex problems.

In 1916, on the death of his kinsman, the last Lord Fitz-Hardinge, Lord Berkeley inherited Berkeley Castle and the Berkeley estates, comprising valuable property in London as well as the lands in Gloucestershire. He left Boar's Hill and devoted himself to the restoration of Berkeley Castle and to other local activities ; for some time he was master of the Berkeley Hounds. His first wife was the widow of Mr. Arthur Jackson. She died in 1898, after which his step-daughter, Miss Sybil Jackson, acted as hostess at Foxcombe. In 1924 he married as a second wife a daughter of John Lowell, of Boston, U.S.A., with whom in these later years he spent much time in Rome and California. He had no children by either marriage and the romantic Earldom of Berkeley becomes extinct. W. C. D. DAMPIER.

Dr. F. Holweck

IT is reported that the French physicist Fernand Holweck died recently in Paris, but the circumstances of his death are not clear.

Fernand Holweck was both a scientific worker and a technician. He had been educated at the École de Physique et de Chimie Industrielles de la Ville de Paris, where Pierre Curie had taught, and became, first an assistant, then a "Chef de Travaux" in Madame Curie's laboratory. He had received the title of Maître de Conférences.

His first important work, for which he received the degree of doctor of science, was on the X-rays of long wave-length (1920–25). He actually filled the gap between the soft X-rays and the extreme ultra-violet rays, by studying the absorption discontinuities characteristic of the K- and L-levels of light elements. Later (1928–38) he extended the study of soft X-rays to their action, and specially their quantic action, on bacteria and viruses.

In the technical field, so early as 1923, Holweck made a helicoidal molecular pump, and a radio emitting valve which could be opened for the replacement of the electrodes. Both proved to be very useful improvements at the time, and were adopted by the French Navy. Later, in collaboration with R. P. Lejay and P. Chevallier, Holweck constructed an improved portable pendulum for gravitation measurements, and he had been working on this subject since 1930.

F. Holweck received in 1927 the Pierson-Perrin Prize for his work on soft X-rays. In 1936 the Paris Academy of Sciences awarded him the Prince Albert I of Monaco Prize for his work on gravitation.

In the War of 1914–18, Holweck served as radio operator. He was married, and had three children. He was a friendly man and liked to crack a good joke. His inventive spirit, his creative skill and his good nature will be greatly missed by physicists.

A FREE FRENCH SCIENTIST.

WE regret to announce the following deaths :

Dr. W. P. Durfee, emeritus professor of mathematics and emeritus dean of Hobart College, Geneva, N.Y., on December 17, at the age of eighty-six.

Dr. Cornelis Winkler, formerly professor of neuropsychiatry at Amsterdam, and honorary member of the Sections of Neurology and Psychiatry of the Royal Society of Medicine, aged eighty-six.

NEWS and VIEWS

Prof. R. A. Daly: Wollaston Medallist

The Wollaston Medal of the Geological Society of London is awarded to honour those who have made "researches concerning the mineral structure of the earth". The very appropriate choice of Prof. R. A. Daly to be this year's recipient of the Medal will be endorsed with enthusiasm by his many friends and admirers. A Canadian by birth and a graduate of the University of Toronto, Daly began his long association with Harvard in 1892, first as a graduate student and afterwards as an instructor in geology. In 1901 he resigned this post to take up a Canadian appointment as geologist on the International Boundary Commission. Ten years of work resulted in a map of, and report on, a 400-mile belt along the 49th parallel from the Pacific, across the Western Cordillera, to the Great Plains. The two following seasons were devoted to the C.P.R. section through the mountains. These arduous years gave him the experience that led to the writing in 1913 of his most famous book, "Igneous Rocks and their Origin", which, rewritten twenty years later as "Igneous Rocks and the Depths of the Earth", remains as an outstanding contribution to petrology. On the resignation of W. M. Davis from the Sturgis Hopper research professorship at Harvard in 1912, Daly was selected as his successor.

This attractive appointment, which enables its incumbent to teach as little and to study and travel as much as he pleases, gave Daly the freedom to carry out a large number of fruitful investigations, many of them based on field studies in distant lands, including South Africa, many of the classic areas of Europe, and a number of oceanic islands. Among his results, presented in a most stimulating series of papers and books, are new theories of granite formation and emplacement, of the origin of alkali rocks, of the mechanisms of volcanic action and mountain building, of the origin of coral reefs and, most recently, of the origin of submarine valleys (see p. 156). Daly has an enviable flair for correlating and attempting to explain the facts of observation—indeed, it is now an old Harvard tradition that "Every morning in the year, Daly has a new idea !"—and it is therefore not surprising that in recent years he has made himself a master of the modern geophysical methods of attacking the fundamental problems of the earth's structure and thermodynamic history. He has, moreover, done much to initiate and guide the long stream of co-operative geophysical research which Harvard has sponsored. Eloquent and influential teacher and writer, and a prolific and successful worker in a variety of challenging fields, he has deserved well of his fellow-geologists and has abundantly earned the honour now conferred upon him by the Geological Society.

Parliamentary and Science Committee

The significance of the contribution being made by science to the war effort was the keynote of the addresses delivered at the first annual luncheon arranged by the Parliamentary and Science Committee (president, the Earl of Dudley), and held on February 3. This body, it will be recalled, was constituted in 1939 to take over the functions of the Parliamentary Science Committee. It consists of members of both Houses of Parliament, and some twenty-seven organizations concerned with scientific activity are affiliated to it. Its purpose is to provide a permanent liaison between scientific bodies and Parliament.

Lord Hankey, Minister without Portfolio, reminded his audience that from his work with the Scientific Advisory Committee, the Engineering Advisory Committee and the Technical Personnel Committee, he is in constant touch with scientific and technical men, and he paid a warm tribute to the eagerness with which they have responded to the call for their services. He then described in general terms some of the steps which have been taken to utilize scientific effort.

The Scientific and Engineering Advisory Committees work in close association, and often through the medium of *ad hoc* conferences formed from appropriate members of the two Committees and with the aid of independent scientific workers. Co-operation with the United States and with the Dominions has been arranged, and there is a constant exchange of individual men of science and of scientific information. So far as Great Britain itself is concerned, Lord Hankey said that all three Fighting Services are "science-conscious"; scientific men are being used, even in the operational side, both individually and in teams, while the universities and technical colleges are providing intensive scientific training for the great numbers of men and women required to operate scientific war apparatus. The reliance on science during the War is, in Lord Hankey's opinion, going to have a big influence on statesmen and officials in the days to come, and he concluded: "I hope and believe that the association of science with government in our hour of need to-day will continue after the War."

Sir Henry Tizard, rector of the Imperial College of Science and Technology, who is now working with the Department of Research and Development, Ministry of Aircraft Production, began by referring to the sense of frustration under which many experienced scientific men are suffering; the present Government and Parliament, however, attach more value to the help and guidance of scientific workers than have any previous Parliament. Science, like war, he pointed out, has its strategy and its tactics. The tactical strength of science in Great Britain is very great; there are well-equipped experimental establishments and, thanks to the innate abilities of our race and to progressive educational policy, a large number of young workers giving high service to the State. The strategical position of science, however, is not so good. In pure science, the fundamental strategy is to attack at the weakest point of the barrier to knowledge; in applied science, the attack must be made where the best results are obtainable. The choice of problem is of crucial importance, and for decisive results effort must be concentrated on it to the exclusion of other matters. The strategy of science in the war effort can only be determined by ever closer collaboration of the man of science with the executive staffs of the fighting and other services. Sir Henry concluded with a striking comparison. The two great driving forces of Western civilization are science and Christianity. The principles and ideals of science, no less than those of Christianity, must sustain and guide all political action which fights for liberty and social progress.

New R.A.F. Bomber

TECHNICAL particulars of the Short 'Stirling', the heaviest bomber of the R.A.F.'s equipment at present in production, have just been released. Squadrons of these machines have been in regular use for long-distance raids for more than a year. Its general dimensions are: length 87 ft., wing span 99 ft., height 23 ft., approximately, and its total all-up weight thirty tons. It carries a disposable bomb load of eight tons. It has a maximum speed of 300 m.p.h. with a range of 2,000 miles, a considerable achievement for a machine of this size; but its principal feature is its manœuvrability which, combined with a heavy armament, makes it capable of protecting itself against air attack by enemy defensive fighters. It has eight 'Browning' machine guns, divided between three gun turrets, in the nose, mid-top, and rear of the body. A crew of seven is the normal complement, and the interior of the body is sufficiently roomy for any of these to man the guns in an emergency. Special precautions are taken against fire, which include carrying all the fuel in self-sealing tanks in the wings well away from the body. The attention that has been paid to the design of the controls in order to obtain good manœuvrability has resulted in extra steadiness in flight in bumpy weather. This not only adds to the comfort and efficiency of the crew, but also provides a steady platform for bomb aiming. The bombs are carried in a central bomb bay, more than forty feet in length inside the body, and are released through hinged doors in the floor.

British Association and the Social Sciences

IN considering possible action in relation to a number of suggestions put forward at the recent conference on "Science and World Order", the executive committee of the British Association's Division for the Social and International Relations of Science has adopted the plan of inviting representatives of specialized bodies and interested individuals to confer with it on particular questions. A preliminary report of these proceedings will be made shortly. Meanwhile, in view of the articles in NATURE of January 24 on the social sciences, the executive committee thinks it will be of interest to announce that such a meeting as has been described above is to be held on February 18, to consider whether the Association, through the Division or otherwise, can take any appropriate action in relation to the position of the social sciences and, if this be found desirable, to take measures accordingly.

Preservation of Stored Wheat in Australia

THE chief insects infesting wheat in Australia are the two true weevils, *Calandra granaria* and *C. oryzae*, and the lesser grain borer, *Rhizopertha dominica*. The last-named threatens to be the most serious pest of bulk-stored grain in the immediate future, being favoured by the high temperatures which, for reasons still somewhat obscure, frequently occur in silos. Every effort is being made to prevent a repetition of the plague conditions of the War of 1914–18. Of precautionary measures, the selection of mean low-temperature localities for stack storages is highly important but not always possible, especially in the western wheat areas. Liquid contact insecticides are proving more effective than the mechanical methods used in the past for sterilization of infested premises, dunnage, stacking sites, etc. Treatment of the grain with certain finely ground non-toxic mineral dusts has been very satisfactory from the entomological point of view; but objection is raised to the resulting appearance, while the change in angle of slip of dusted, as compared with clean, poured wheat, introduces quite a big and unexpected practical difficulty in modern bulk-handling procedure. Though stacked wheat cannot be readily fumigated, tests in silo bins have been successful, and in Western Australia fumigation of bulk wheat is likely to be adopted on a large scale. So far the problem presented in Australia is much less severe than it became in 1914–19, and every effort is being made by the Wheat Board, in collaboration with the Council for Scientific and Industrial Research, to ward off serious developments.

Protective Gear on Power Supply Systems

AN interesting paper entitled "The Management of Protective Gear on Power Supply Systems", read recently in London before the Institution of Electrical Engineers by W. Casson and F. H. Birch, of the Central Electricity Board, discusses the theoretical and practical considerations affecting protective-gear engineering. After reviewing the responsibilities and qualifications of protective-gear engineers the authors investigate a number of typical system fault conditions, giving methods of calculating fault currents and voltages, the relations between which are illustrated by vector diagrams. System abnormalities other than faults are discussed and attention is directed to their relation to protective-gear operation. The performance and correct application of protective gear are stated and a general outline of the work of commissioning the gear is given according to the type in use. Testing methods and testing equipment are described and consideration is given to protective-gear troubles and routine maintenance procedure. Finally, the paper discusses those features of protective-gear design, construction and layout which assist maintenance. The paper is based upon experience obtained during the last ten years with protective gear installed on the Grid system in Great Britain which, while having been designed primarily for peace-time fault conditions, has been found to give an overall fault performance of 92 per cent correct in 1940 when, due to war-time hazards, operating conditions were exceptionally severe.

Recent Earthquakes

THE Jesuit Seismological Association of Saint Louis, U.S.A., has determined the epicentres of several recent important earthquakes. From an analysis of twelve seismograms obtained at observatories throughout the United States, the earthquake of September 24, 1941, at 01h. 01m. 27s. U.T. is considered to have had a tentative epicentre at lat. 50·0° N., long. 158·3° W. This is in the Pacific Ocean, south of the Alaska Peninsula, and the focal depth of the shock is estimated by the Brunner depth chart to have been near 100 km. On the basis of reports from ten stations, the earthquake of September 25, 1941, at 17h. 48m. 49s. U.T., had its tentative epicentre at lat. 20·3° N., long. 155·1° W. This is in the Pacific Ocean, just a little to the north of the island of Hawaii. A third, and probably the most important of these three shocks, occurred on November 25, 1941, at 18h. 03m. 57s. U.T. It was recorded with very great ground amplitudes at observatories throughout the world (NATURE, December 6, 1941, p. 690). To obtain the epicentre of this earthquake, Edward J. Walter used the readings of seismograms from twenty-six observatories, mostly in North America and the Pacific Islands, and obtained a tentative epicentre at lat. 37·3° N., long. 19·1° W. This is in the north Atlantic Ocean, between the Azores and Portugal. Undoubtedly, if this earthquake had had an epicentre near any populated area, it would have caused widespread destruction.

Bibliography of Pharmacology and Chemotherapy

BEGINNING with Vol. 3 (1942) the name of the "Bibliography of Pharmacology" is changed to "Bibliography of Pharmacology and Chemotherapy". No change in scope is contemplated: "Chemotherapy" is added only to make the title more accurately descriptive. The publication is a reference list of current American and foreign literature relating to the action of known chemical compounds (natural or synthetic) on animal organisms and to therapeutic use of such compounds, including clinical investigations but not including routine clinical and case reports. The annual subscription rate is 3.50 dollars, or 2.50 dollars to members of the Friends of the Hooker Scientific Library. Further information can be obtained from the Hooker Scientific Library, Central College, Fayette, Missouri.

Regnier de Graaf, 1641–73

DR. H. R. CATCHPOLE, of the Yale University School of Medicine, has directed attention to the occurrence last year of the tercentenary of the birth of the Dutch physician and anatomist, Regnier de Graaf, who at the age of twenty-two wrote a treatise on the pancreatic juice and when thirty-one discovered the Graafian follicles of the ovary. De Graaf was born at Schoonhove on July 30, 1641, and died at Delft on August 17, 1673, at the early age of thirty-two. He was the son of an architect, and he studied medicine at the University of Leyden. Then he travelled into France, receiving a doctor's degree at Angers and at Paris, making the acquaintance of the savants of the time. Returning to Holland, he settled at Delft, married, and continued the researches for which he is remembered. Haller says his death was occasioned by a very heated dispute he had with Swammerdam.

George Martine

SIR D'ARCY THOMPSON has recalled in a recent article (*Scotsman*, Dec. 27) the work of the eighteenth-century Scottish physician, George Martine, who died in 1741. Martine went to the University of St. Andrews at the age of thirteen, and later proceeded to Leyden to study under Boerhaave; there he took his M.D. in 1725. He returned to practice in St. Andrews, and at the age of about forty was made fleet surgeon to Admiral Vernon for the Cartagena expedition. Smollett was a surgeon's mate in the same expedition, and Sir D'Arcy believes that his surgeon Macshane in "Roderick Random" was really Martine. Martine died of malarial fever when the expedition was in the Caribbean Sea.

Martine was a good mathematician and natural philosopher as well as a physician, and in Sir D'Arcy's opinion narrowly missed making some of Black's cardinal discoveries. In "De Similibus Animalibus" (1740) he discussed the effects on the circulation of change of magnitude in an animal, now known as the principle of similitude; in "De Calore Animalium" (also published in 1740) he dealt with the heat of warm-blooded animals, which he believed was due to friction of the blood on the walls of the blood vessels. He knew that the temperature of the skin of a man is about 97°, while that of dogs, cats, oxen and swine is higher and of birds highest of all. He wrote several papers on heat and the early history of the thermometers, and had a good notion of an absolute zero. His papers on medical topics included one "On Periods and Crises of Disease", while a paper on a tracheotomy performed in St. Andrews, including a description of a double cannula suggested by "one of our Ministers here" is printed in the *Philosophical Transactions* of 1730.

Cecil Peace Prize

A CECIL Peace Prize of £100, open to all undergraduates, without distinction of sex or nationality of any university or university college in Great Britain or Northern Ireland, who have attained the age of twenty-five on the last day of submitting essays, is offered for 1942. The subject is: "In what sense did the League of Nations succeed or fail?" The Prize for the 1941 essay has been awarded to The Hon. N. H. C. Bruce, Oriel College, Oxford; *Proxime accesserunt*, L./Cpl. R. James, University of Liverpool, and Miss Eileen Taylor, St. Hugh's College, Oxford. Further information can be obtained from the Secretary, University Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

X-Ray Analysis in Industry

THE Institute of Physics is arranging a conference on "X-Ray Analysis in Industry" to be held in Cambridge during April 10–11. The purpose of the conference is to promote the interchange of knowledge and experience between those employing X-ray analysis (diffraction methods) in their work in different fields, and to arrange for further collaboration between physicists, engineers, chemists and others towards the solution of problems by its methods. The discussions, which will be based on papers included in the symposium already published by the Institute (*J. Sci. Inst.*, May and July, 1941), will be informal. During the conference, Sir Lawrence Bragg will deliver a lecture on "The History and Development of X-Ray Analysis". Further particulars can be obtained from the Secretary of the Institute of Physics, temporary address, University, Reading, Berks, to whom application for accommodation in Cambridge should be made before February 14 next.

Announcements

PROF. C. LOVATT EVANS, Jodrell professor of physiology in University College, London, has been elected an honorary member of the Sociedad Argentina de Biologia.

CAPTAIN N. H. HECK, chief of the Division of Terrestrial Magnetism and Seismology of the U.S. Coast and Geodetic Survey, has been awarded the degree of doctor of science by Fordham University, for his distinguished work in connexion with seismology.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Emulsification and Absorption of Fats and Paraffins in the Intestine

It has been shown by Frazer[1,2,3] that a fat, such as triolein, is only partially digested in the intestine by the pancreatic juice. Hydrolysis determines the path taken by the absorbed fatty material, the fatty acid fraction passing by the portal vein to the liver, and the unhydrolysed portion by the lymphatic route into the systemic blood and thence to the fat depots. This conception is contrary to the previously accepted hypothesis of Verzar[4] that the fat was completely hydrolysed, and the resultant fatty acid was carried through the intestinal membrane by means of a complex formation with the bile acids and resynthesized to fat again in the cells before being transported into the blood stream via the lacteals. The absorption of unhydrolysed fat raises a special complication, since triglyceride behaves physico-chemically very much like paraffins, which are not normally absorbed from the intestine. Furthermore, it is easy to show that bile acids or their salts form no complexes with either triglyceride or paraffin but only with fatty acid.

It was considered that in the intestine there was an ideal system for causing an emulsion of olive oil to be formed; there is present some oleic acid due to the action of the pancreatic lipase on the olive oil, some soda to form sodium oleate *in situ* on the surface of the olive oil globule, and cholesterol to keep the sodium oleate at the interface by complex formation (Schulman, Cockbain and Alexander[5,6]). This was proved by making a spontaneously forming emulsion of olive oil in water by dissolving 0·2 per cent of oleic acid and 1 per cent cholesterol in olive oil, and pouring the mixture into an $N/10$ soda solution. This emulsion was much better than one formed by pouring an olive oil – cholesterol mixture into a sodium oleate solution, containing an equivalent amount of sodium oleate as would be formed by the oleic acid and soda, added separately. Probably in the former case the sodium oleate is formed at the surface where it is required, while in the latter case an adsorption to the oil/water interface would have to take place; this requires time and a large artificially formed surface as produced in an emulsifying machine.

Further, it can be shown that in the intestine of rats which have been given a quantity of olive oil, strong emulsification of the olive oil can be seen, whereas in a rat that has been given liquid paraffin no emulsification is observed, but only the free oil, which has not been absorbed. It was therefore considered that the absorption of the olive oil by the intestine is brought about by the fact that the oil is emulsified, and that the droplets of $\frac{1}{2}\,\mu$ in diameter can be ingested by the brush membrane of the intestine. On this hypothesis, therefore, it should be possible for the intestine to absorb liquid paraffin, should the paraffin be in the form of an emulsion in the intestine. This was shown to be the case. If small quantities of oleic acid and cholesterol be added to the paraffin, which can then be emulsified in the usual way, and the emulsion injected into the duodenum, or if the mixture be given into the stomach and emulsification permitted to take place spontaneously in the intestine, strong absorption of the liquid paraffin takes place. This absorption was similar to that obtained for olive oil alone. In the control experiments negligible absorption of the paraffin alone took place.

The absorption of liquid paraffin by the intestine was demonstrated in rats by three methods: histologically, biochemically, and by chylomicrographs. Histologically, the staining of the paraffin oil droplets in the intestinal wall cells was most marked. These droplets, as seen in frozen sections, appeared to be of the order of $\frac{1}{2}\,\mu$ diameter. The control experiments with unemulsified paraffin showed no Sudan-stained droplets in the intestinal membrane cells.

Biochemically, the absorption of emulsified paraffin was found to be as high as 60 per cent of the quantity administered, which compared favourably with the absorption of olive oil in control animals over a similar time-period.

The chylomicrograph is constructed from counts of fat particles in the blood made under standardized conditions (Frazer and Stewart[7,8]). By serial investigation at 30-min. intervals the passage of absorbed fatty material in the blood stream can be observed. A chylomicrograph similar to that obtained with olive oil with a peak of 200 particles per field was found with good paraffin emulsions. Coarser paraffin emulsions containing no cholesterol gave a peak of 100 particles per field, and unemulsified paraffin only about 20–30. All these counts were from made systemic blood from the rat's tail and heart.

The interesting problem now arose as to how a paraffin droplet of $\frac{1}{2}\,\mu$ diameter could be absorbed by the intestine. A possible clue to this question might come from some unpublished work of Pantin and Schulman, who showed that nematocysts of sea anemones would shoot and stick when the nematocyst cell has been touched by some paraffin, but not when the paraffin has been made hydrophilic on the surface by the presence of fatty acid or protein. It could thus be supposed that the paraffin or olive oil will not stick to the intestinal wall unless the oil droplets have a hydrophilic coating as they have in the case of stabilized oil-in-water emulsions. Further, it might be supposed that the droplet must be of the size of $\frac{1}{2}\,\mu$ or of a smaller diameter before the membrane can ingest the particles on the amœboid or phagocytic principle. This particular dimension of the droplets is that which is found in stabilized emulsions.

The part the bile acids play in the intestine is not quite clear. It can be shown by the emulsion technique that the association of the bile acids is strong to oleic acid; this association is weakened with the bile acid salts, whereas no association can be established for the bile acids with olive oil or paraffin. Pantin and Schulman showed with the nematocyst experiments that the bile acid salts made the nematocysts all shoot spontaneously, whereas the other capillary active compounds, such as long-chain sulphate, amine and carboxylic salts, only cytolized the cells. The bile acid salts, since they form no complexes with compounds other than the fatty acids, do not lower the interfacial oil/water tension of these complex systems, as compared with the other capillary active compounds, and are, therefore, very poor emulsifying agents. Further, the bile acid molecule containing several polar groups cannot pack into the interface as compared to a normal straight-chain compound with one polar group. This is borne out in the poor surface-tension lowering properties of the bile acid salts.

The details of this work will be published elsewhere.

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Jan. 14.

[1] Frazer, A. C., *Analyst*, **63**, 308 (1938).
[2] Frazer, A. C., *J. Physiol.*, **94**, 24*P* (1938).
[3] Frazer, A. C., *Physiol. Rev.*, **20**, 561 (1940).
[4] Verzar, F., "Absorption from the Intestine" (London, 1936).
[5] Schulman, J. H., and Cockbain, E. G., *Trans. Farad. Soc.*, **36**, 651 (1940).
[6] Schulman, J. H., and Alexander, A. E., *Trans. Farad. Soc.*, **36**, 960 (1940).
[7] Frazer, A. C., and Stewart, H. C., *J. Physiol.*, **90**, 18 (1937); **65**, 68 (1939).
[8] Frazer, A. C., and Stewart, H. C., *J. Physiol.*, **95**, 21, 23*P* (1939).

Toxic Effects of Certain Bacterial Metabolic Products on Soil Protozoa

THE chemotherapeutic value of the antibacterial substances produced by micro-organisms has attracted much attention in recent years. Very little is known concerning the effect of these antibacterial substances on Protozoa. For the past few years I have carried out work[1,2,3] on the selectivity of bacterial food by soil Protozoa, with special reference to amœbæ. In an attempt to correlate the non-edibility of pigmented bacteria, a suggestion[3] has been made that pigment formation by bacteria exerts a protective action against protozoal attack.

The extracted pigment from *Serratia marcescens*, *Chromobacterium violaceum* and a red pigmented bacterium 5654 (the characters of which are given by me[1]), when mixed with edible bacterial suspensions on an agar plating, apparently prevents the amœbæ from eating the edible food. Within a few days the amœbæ either encyst or die without destroying more than a few of them. Non-pigmented strains of *Serratia marcescens* are slowly but completely destroyed by amœbæ. The pigment of *Serratia marcescens* diffusing through agar has also a toxic effect on soil amœbæ and prevents them from eating edible bacteria.

Some interesting observations have been made on the toxic effect of the metabolic products of *B. pyocyaneum* on soil Protozoa. When the organism is grown on glycerol-peptone agar for 3–30 days, a chloroform extract of the bacterial growth, redissolved in water, is very toxic in strong concentrations to soil amœbæ, flagellates and ciliates, which are killed in a few minutes. At dilutions of 1/2,000 and 1/4,000, it takes 3–8 hours and 12–48 hours respectively to kill Protozoa, the effect at a given dilution varying with the type of protozoan. At dilutions of 1/8,000 and above, some types of Protozoa are killed within forty-eight hours while others are unaffected. Schoental[4] has studied the antibacterial agents present in cultures of *Ps. pyocyanea*, which include α-hydroxyphenazine. The chemically pure pyocyanin and α-hydroxyphenazine are less toxic to soil Protozoa than the above-mentioned crude chloroform extract. The chemically pure pyocyanin is slightly more toxic than α-hydroxyphenazine.

The more toxic nature of the crude extract is thus probably due to the fact that it contains other substances in addition to pyocyanin. When the crude chloroform extract of pyocyanin, dissolved in water, is passed through an *L* 5 Chamberland candle, the pyocyanin is adsorbed by the candle, and a light tea-coloured filtrate is obtained, the toxicity of which on Protozoa is increased by autoclaving at 15 lb. pressure for 15 min. The nature of this substance is being studied.

A fluorescent pigment, which is quite different from pyocyanin, obtained by growing *B. pyocyaneum* in liquid media, is also toxic to soil Protozoa.

A detailed study of the work carried out on the toxic effect of bacterial products on soil Protozoa will be published later, and it is hoped to extend this study to the effects of other antibacterial substances produced by micro-organisms on pathogenic and soil Protozoa.

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[1] Singh, B. N., *Ann. App. Biol.*, **28**, 52 (1941).
[2] Singh, B. N., *Ann. App. Biol.*, **28**, 65 (1941).
[3] Singh, B. N., *Ann. App. Biol.* (in the press).
[4] Schoental, R., *Brit. J. Exp. Path.*, **22**, 137 (1941).

A Useful Abnormality of the Pollen in a Pear

THE exceptionally low number of good seeds obtained when the pear variety Beurré Bedford is used as pollen parent in breeding experiments[1] led me to observe a series of developmental aberrations in this variety which may prove of value in producing new and improved forms.

The variety is a diploid ($2n = 34$), but, following normal meiosis, cell walls fail to develop between the four haploid nuclei, and thus the pollen mother cells are transformed directly into giant four-nuclear pollen grains.

Immediately before the first pollen grain mitosis these nuclei begin to fuse with one another, so that the following five types of mature grains, classified according to the number and constitution of the generative nuclei, are produced:

Types	$4x$	$3x+x$	$2x+2x$	$2x+x+x$	$x+x+x+x$
Percentage	81·5	9·3	6·9	1·9	0·4

The pollen grains of all these types germinate readily in culture (more than 90 per cent germination) and with more vigour than pollen from normal diploid and tetraploid varieties. The pollen tubes are almost invariably branched, although generative nuclei can be observed in only one of the branches. Such branching cannot be attributed to the multi-nuclear nature of the cells, since more than 80 per cent of the pollen grains have the vegetative as well as the generative nuclei single.

Growth of these pollen grains is also vigorous in stylar tissue and the tubes enter the embryo-sac in the normal manner[2], but very few good seeds are obtained[1].

In crosses with diploid and tetraploid varieties

B. Bedford gives progeny with the following chromosome numbers:

	$2x$	$3x$	$4x$	$5x$	B.B. gametes
$2x$ × B. Bedford ♂	7	—	4	—	x, $3x$
$4x$ × B. Bedford ♂	—	—	3	2	$2x$, $3x$
B. Bedford ♀ × $2x$	10	—	—	—	x
B. Bedford ♀ × $4x$	—	3	—	—	x

Thus on the female side gamete formation is normal while on the male side there is a strong selection of particular types from those provided by its irregular behaviour.

This behaviour affords us a means of synthesizing a wide range of new polyploid forms of pear by using Beurré Bedford as a male parent in crosses with existing varieties.

P. T. THOMAS.

John Innes Horticultural Institution,
Merton, London.
Jan. 16.

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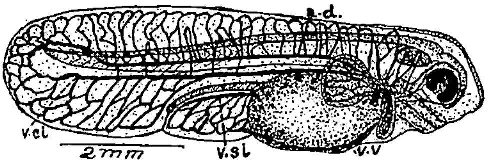
[1] Crane, M. B., and Lewis, D., *J. Genet.* (in the press).

[2] Lewis, D., and Modlibowska, I., *J. Genet.* (in the press).

The Tail of a Fish Larva as Respiratory Organ

RESPIRATION through provisional organs is found in many tropical fishes. Rauther[1] has summarized this subject and Kryzanovski[2] has lately described the respiration in the teleostome fish embryos and larvæ. In cases where the circulation develops before the proper respiratory organs, Krogh[3] says that part of the animal surface functions provisionally as a respiratory organ. Capillary or lacunar systems of blood vessels are indicated by Kryzanovski as a respiratory system of certain Cichlidæ fishes, which have the anal or the dorsal fin slightly vascularized.



"TRAIRA" LARVA. *a.d*, AORTA DORSALIS; *v.ci*, VENA CAUDALIS INFERIOR *v.si*, VENA SUBINTESTINALIS; *v.v*, VENA VITELLINA. LIVING ANIMAL.

I have observed several larvæ, 6–7 mm. long, of the Brazilian fish called "Traira" (*Hoplias malabaricus*), the tail of which is largely provided with a compact vascular net. The blood proceeds from the heart by the *aorta dorsalis* (*a.d.*) and runs in the tail through a great number of capillary blood vessels forming many loops, thus increasing the respiratory surface. In this manner the preanal, anal and dorsal fins appear densely vascularized. The loops return to the *vena caudalis inferior* (*v.ci.*) and the *vena subintestinalis* (*v.si.*). Part of the oxygenated blood comes back to the heart by these capillary vessels; the rest of the blood runs to the heart through the vitelline vein (*v.v.*).

"Traira" larvæ are provided with thin jugular fins moving quickly. These fins also have a number of capillary blood vessels. Under the Greenough microscope the circulatory current can be seen running into the smallest capillaries distributed in an extremely thin vascular net. Some capillaries coming from the head and around the eyes also carry blood to the heart. Only rarely have I seen many flagellates on the tail surface, probably Bodo, commonly an indicator of the presence of oxygen.

None of the fish larvæ examined had either gills or the mouth completely formed.

Such a characteristic aspect shown by "Traira" larvæ is comparable only with that figured by Kryzanovski in *Acipenser stellatus*, but this fish does not possess a caudal vascular net so compact as that of "Traira" larvæ. Krogh, in his recent book, indicates the tail as a respiratory organ in the young Acara, but it was impossible to obtain more information about this interesting tropical fish on this matter.

Further researches on these lines are proceeding, and it is hoped to publish the details soon.

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[1] Rauther, M., *Ergb. Fortsch. Zool.*, 2 (1910).

[2] Kryzanovski, S. G., *Zool. Jahrb. Abt. Anat. u. Ont.*, 58 (1934).

[3] Krogh, A., "The Comparative Physiology of Respiratory Mechanisms" (Univ. Pennsylvania Press, Philadelphia, 1941).

Mechanism of Kinetic Friction

FROM the recent paper by Morgan, Muskat and Reed[1], on "Friction Phenomena and the Stick-Slip Process", it is apparent that their ideas and experiments are progressing on lines similar to our own.

It has long been thought in this Laboratory that the Bowden and Leben[2] friction-measuring apparatus, in which a slider under elastic control presses on a plate which moves at constant velocity, shows by its 'stick-slip' motion merely that kinetic friction (F_K) is less than static (F_S); and we agree with Morgan, Muskat and Reed that Bowden and Leben did not give sufficient consideration to the dynamics of their system. It follows from the elementary treatment of oscillations with Coulomb damping, in which it is assumed that F_S is greater than F_K and that F_K is independent of velocity, that relaxation oscillations of the type shown by Bowden and Leben will occur (see Thomas[3] on "Vibrations Damped by Solid Friction"). It does not follow, however, that, if relaxation oscillations do occur, the above assumptions are true. For, provided the F_K-velocity curve falls rapidly, with increase of velocity over the lower ranges of velocity, relaxation oscillations of the same apparent form will be obtained; and without detailed analysis of the 'slip' portion of the cycle, and probably additional experiments, it is not possible to deduce from Bowden and Leben's papers, or others describing work with similar apparatus, any information regarding F_K, except that in general F_K is less than F_S.

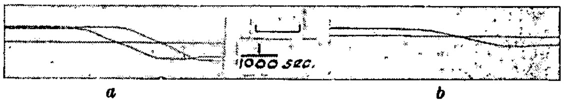

Fig. 1.

HARDENED STEEL SLIDING ON NICKEL LUBRICATED WITH NUJOL: *a*, PLATE SPEED, 0·01 CM. PER SEC.; *b*, PLATE SPEED, 1·0 CM. PER SEC.

It recently became necessary, with the use of an apparatus of the Bowden-Leben type, in measuring the coefficient of friction for lubricated and unlubricated metals in contact, to examine the system in detail. Records taken, with a high-speed camera, of the 'slip' part of the cycle (Fig. 1), together with those of the free oscillations, show subsidiary oscillations in the system which preclude accurate analysis of the motion. Experiments have also shown a marked decrease in amplitude of the 'stick-slips' with increasing lower plate speed (Fig. 2). It would follow, at first sight, from the simple assumptions above, that F_S decreases as the rate of wind up of the spring increases, and that F_K is constant over the whole range of speeds.

Actually, as already mentioned, no such deductions can be made without further investigation. Moreover, measurements show that during the 'stick' there is a slow creep back of the top slider, which increases as the lower plate speed increases. This implies that F_K is, at low velocities, not less than, but greater than F_S, rising to a maximum with increasing velocity, and then, to give the 'slip', falling rapidly; this would agree with an observation by Papenhuyzen[4] with rubber sliding on glass and road surfaces. In the present experiments, however, there is an inconsistency in that this rise in F_K is not shown when the plate speed is reduced to the appropriately low values. This anomaly, implying a progressive change in height—with plate speed—of the maximum of the F_K-velocity curve (top of 'stick', that is, apparent static value), may be peculiar to this instrument in so far as displacement is accompanied by twisting of the top slider relative to the lower plate; this may give enhanced adhesion at low plate speeds, as noted by Tomlinson, Thorpe and Gough[5], the effect decreasing as plate speed increases (that is, speed of twisting increases). The further analysis of these results, and the experiments now in hand to clarify the position, will be described at some later date, but it is apparent that the observations made with this apparatus previously published are superficial as regards fundamental information on kinetic friction.

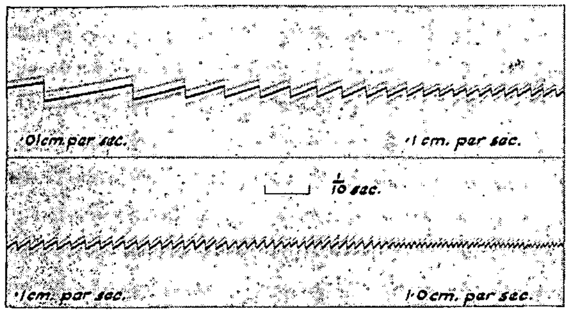

Fig. 2.

LEAD-ANTIMONY EUTECTIC SLIDING IN HARDENED STEEL (DRY).

Further to the considerations of the dynamics of the measuring system, two other points may be mentioned. (1) As yet temperature flashes of more than 30° C., during slip, have not been recorded, in agreement with the order given by Morgan, Muskat and Reed (50° C.). Some widely varying temperature distribution over the contact area is therefore necessary to make hot welding possible as part of the phenomenon. Further, it may be noted that the speed of 'slip', and therefore the temperature rise, will depend on the dynamics of the particular system; the 'stick-slips' are still obtained when the speed of slip is reduced to 1/100 of its normal value with this apparatus, suggesting that high temperature rise is not essential to the 'stick-slip' behaviour. (2) It has been suggested by Bowden and Leben[6], and Tabor[7], that the exhibition of 'stick-slips' is indicative of poor boundary lubrication. Apart from the difficulty of seeing why the mere fact of F_S exceeding F_K should imply poor lubrication, it has been found that smooth sliding can be obtained, using dry surfaces, at a value of F_K exceeding the whole range of 'stick-slips' for the same surfaces lubricated. Moreover, the damage during smooth sliding was much the greater. This friction result is corroborated by Morgan, Muskat and Reed, who have failed to correlate the presence or absence of 'stick-slips' with the values of F_S. It follows, therefore, that the above suggestion requires at least very careful qualifications.

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National Physical Laboratory,
Teddington, Middlesex. Jan. 13.

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[1] Morgan, F., Muskat, M., and Reed, D. W., *J. App. Phys.*, **12**, 743 (Oct., 1941).

[2] Bowden, F. P., and Leben, L., *Proc. Roy. Soc.*, A, **169**, 371 (1939).

[3] Thomas, S., *Phil. Mag.*, 9, 329 (March, 1930).

[4] Papenhuyzen, P. J., *De Ingenieur* (Utrecht), **53**, 75 (1938).

[5] Tomlinson, G. A., Thorpe, P. L., and Gough, H. J., *Proc. Inst. Mech. Eng.*, **141**, 230 (May, 1939).

[6] Bowden, F. P., and Leben, L., *Phil. Trans. Roy. Soc.*, **239**, 1 (1940).

[7] Tabor, D., *Eng.*, **152**, 178 (1941).

Determination of Moisture

Several writers have recently discussed in Nature[1,2,3] methods for the determination of the moisture content of small samples of biological material. It has occurred to us that the method we have described[4] for the measurement of moisture in electrical insulating materials might be of great use in this connexion. In brief, the method consists of the removal of moisture from the specimen *in vacuo*, the moisture being retained in the specimen during the initial evacuation by cooling in solid carbon dioxide. The moisture removed on heating the sample to a constant temperature is then measured by observing the water vapour pressure produced at atmospheric temperature in a globe of known volume. Complete removal of the water is not attempted, but a graphical extrapolation is used to determine the total moisture content from the measured equilibrium water vapour pressure.

A trial of the method with biological material has been made, using small samples of egg white and yolk. Determinations were made using samples weighing only 30 mgm. and it was found that the yolk contained 48·6 per cent moisture and the white 82·2 per cent. The method has also been used satisfactorily for measuring the moisture content of honey. Even smaller samples could be examined, since the method is so sensitive; 1 mgm. of water vapour produces a pressure of about 4 cm. of oil in the present apparatus. The method cannot produce oxidation of the sample, since no oxygen is present. The temperature of the sample in the above tests was 120° C. but lower temperatures can be used for samples which might be unstable at such temperatures. In the original description of the method, measurements on paper at 0° C. were quoted.

R. S. Vincent.
A. Simons.

Callender's Cable and Construction Co., Ltd.,
Erith Works,
Belvedere, Kent.

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[1] Lowndes, A. G., Nature, **148**, 594 (1941).

[2] Holt, P. F., and Callow, H. J., Nature, **148**, 755 (1941).

[3] Warne, L. G. G., Nature, **148**, 756 (1941).

[4] Vincent, R. S., and Simons, A., *Proc. Phys. Soc.*, **52**, 489 (1940).

HORMONAL INCREASE OF RESISTANCE AND ITS MECHANISM

By PROF. ERIK AGDUHR
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INVESTIGATIONS already published[1, 2] have made it clear that pregnancies cause an increased cell vitality in the mother organism, and that they can even bring about a not inconsiderable organ increase there. It has also been found that the pregnancies give rise to a heightening of resistance to injurious factors[3]. A similar heightening of resistance is produced by normal sexual functions. In earlier publications[3] it has been shown how normal sexual functions in both sexes raise the resistance to a number of different toxic agents, as, for example, large repeated doses of activated ergosterine, different metal salts, alcohols, narcotics, paratyphus cultures, diphtheria toxin. The injurious factor most commonly used in my experiments was arsenic trioxide, and the most usual animals were white mice, though white rats and rabbits were also included in a number of experiments. All the animals received the complete basal diet. In most of the experiments the toxic agent was administered in proportion to the body-weight, and in doses increasing daily until the animals died.

Numerous experiments (1935 and later[3]) have made it possible to establish as correct the view already expressed in my first publication in this field (1931), that the results are conditioned by hormones. A considerable increase in resistance was obtained from giving œstrone (Ovex, Leo) and testosterone (testo-steronpropionate, perandren) to castrated animals, and Antex, Leo (gonadotropic, pars anterior, pituitary hormone, obtained from pregnant mares) to animals without normal sexual functions ('celibate animals')—an increase which, in some experiments, exceeded that which normal sexual functions (*m*) were able to set up.

In mice treated with colchicine, mated animals showed a much greater number of mitoses, *inter alia*, in the interstitial cells as well as in the follicular epithelium cells of the sexual glands than the unmated ones. This indicates a richer production of sexual gland hormones in mated animals[4].

The increase in resistance among the *m* animals was as a rule greater in the females than in the males. This appears to me to be due to the fact that in the latter, only the sexual association had a resistance-promoting effect, whereas the former have yet another such effect in their pregnancies.

Comprehensive investigations have shown that the resistance imparted by the pregnancies stands, at any rate to a certain extent, in proportion to the number of pregnancies passed through. As an example, it may be said that in an experiment comprising 35 mated females, 16 of them had been through more than half of the theoretically maximal number of pregnancies, while 17 had been through less than or half this maximum. All the animals were killed with arsenic trioxide solution with 0·05 per cent arsenic. The solution was administered at 0·1 c.c. per 20 gm. body-weight, and the dose rose daily at 0·02 c.c. per 20 gm. body-weight.

The result was :

$$D = \frac{M}{16} - \frac{M}{17} = 0{\cdot}0328 \pm 0{\cdot}00775 \text{ mgm. arsenic per gm. bodyweight}^{5}.$$

Here, therefore, we have a statistically significantly greater increase of the resistance, caused by a greater number of pregnancies among animals otherwise equal and comparable, belonging to the same experimental series[6].

Quantitative micromorphological analyses *inter alia* showed the occurrence of an important increase in number of the acidophil (eosinophil or alpha) cells of pars anterior of the pituitary body of mated females. As is well known, these cells produce a growth-hormone, which increases the vitality of the cells as well[7].

Statistical investigations have shown that married people live longer than unmarried ones, and that this increase of the span of life is more marked among women than men. Cancer of the breast and diseases of the heart are more frequent among unmarried women than among married. In my opinion there is no doubt that in the human being also, endocrine factors are the true explanations for this heightened resistance among married individuals, agreeing in principle with what the experiments with white mice have shown.

An association before puberty of females (white mice at an age of thirty days) with the opposite sex speeds up the setting in of puberty, also characterized by a retrogression of the thymus which starts earlier than it would otherwise. Compared with females which were admitted to cohabitation with the males at an age from about 175 days, the first-mentioned animals show a greater increase in resistance, probably most nearly due to the fact that the number of pregnancies they go through is greater not only absolutely, but also in relation to the length of the fertility period. Quite the opposite is found to obtain among the males as regards the gradual appearance of the resistance increase following an early and a late start respectively of sexual relations.

Study has been devoted to the mechanism at the appearance of the heightened resistance to arsenic trioxide, in which it has been shown that two systems of factors play a part. One system is set up by the sexual functions and the other by the pregnancies. The effect of both these systems is to a certain extent antagonistic with regard to the arsenic storage. The sexual functions, on account of an increased production of sexual hormones in both sexes and also a number of tested sexual hormones, cause an increased storage of arsenic in organs rich in ground substance or stroma tissues, and particularly in the skin. Females with a number of pregnancies that, reckoned per time unit, is percentually greater, have shown a slighter arsenic storage, at the same time as the lethal quantities of arsenic have been considerably larger reckoned in mgm. per gm. body-weight[8]. This effect is obtained by an increased function of the eosinophil glandular cells of pars anterior of the pituitary body. The hormone produced by these cells causes an increased vitality of the cells and as a consequence also an augmented excretion of the arsenic.

It would therefore seem that the heightened resistance which the normal sexual functions bring about is most nearly due to the fact that the increased storage in the ground substance or stroma tissues to some extent liberates the more sensitive and more important parenchyma cells from toxic influences. On the other hand, the pregnancies give rise to an increased cell activity, and, as a result, an increased excretion from the organism of the toxic substances.

This in its turn explains the smaller storage in larger numbers of pregnancies.

As the skin in particular has been the place where arsenic was stored, it has been studied in more detail, whereby it has been seen that sexual functions and sexual hormones bring about an obvious check to the spreading possibilities which the skin otherwise shows, and also that they give rise to an increase in the thickness of the corium and a distinct increase of non-ether-soluble dry substances reckoned per unit skin surface. These results all seem to explain the increase of arsenic storage in the skin of both *m* and *u* animals dosed with Antex, Leo, or castrates which have been given Ovex, Leo (=œstrone), and testosterone respectively.

The expenses of this investigation were defrayed by grants from Stiftelsen Thérèse och Johan Anderssons Minne, The Caroline Institute, Stockholm, and from the Regnells fund of the University of Uppsala.

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[1] Agduhr, Erik, *Verhandl. Anatom. Gesellsch. Erg. z. Anat. Anzeig.*, **72**, 63 (1931).

[2] Agduhr, Erik, *Upsala läkareffören. förhandl.*, N.F. **38**, 1 (1932).

[3] Agduhr, Erik, (*a*) *Upsala läkareförenings förh.*, N.F. **38**, IV (1932); *ibid.*, **39**, 307 (1934); *ibid.*, **40**, 183 (1935); *ibid.*, **42**, 463 (1937); *ibid.*, **43**, 1 (1937); *ibid.*, **47**, 1 (1941); (*b*) *Verhandl. Anat. Gesellsch. Erg. z. Anat. Anz.*, **72**, 63 (1931); (*c*) *Z. mikrosk. anatom. Forschung*, **36**, 576 (1934); *ibid.*, **45**, 3; S. 467 (1939); *ibid.*, **49**, 589 (1941); (*d*) *Z. Vitaminforsch.*, **4**, 66 (1935); *ibid.*, **5**, 27 (1936); (*e*) *Skandinavisch. Arch. f. Physiol.*, **2** (1937); 5th Northern Congress of Physiology, Uppsala (1937); *ibid.*, **77**, 4; *ibid.*, **77**, 5 (1937); *ibid.*, **78**, 6 (1938); (*f*) *Hygiea*, **100**, 2 (1938); (*g*) *Meddelande fr. Sällskap. veterinärmedicinsk Forskning*, **24** (1940); *Skand. vet. tidskr.* (1941); (*h*) *Archiv. internation. Pharmacodyn. et Thérap.*, **59**, 269 (1938); (*i*) *Acta Medica Scandinavica*, **99**, 387 (1939); (*j*) Barron, D. H., *Archiv. internation. Pharmacod. et Thérap.*, **58**, 351 (1938).

[4] Agduhr, Erik, *Z. mikrosk. anatom. Forschung*, **49**, 603 (1941).

[5] $\frac{M}{16}$ = Mean for sixteen animals.

[6] Agduhr, Erik, *Upsala Läkareför. förhandl.*, N.F., **47**, 1 (1941)

[6] Agduhr, Erik, *ibid.*, **38**, IV (1932).

[8] Agduhr, Erik, *ibid.*, **47**, 1 (1941).

PERMIAN FOSSILS FROM THE EASTERN HIMALAYA*

IN 1849, having traversed the igneous and metamorphic rocks of the Sikkim Himalaya, Joseph Hooker discovered a limestone containing fragmentary organic remains. The fossils were thought to be nummulites, but afterwards they were shown to be crinoid ossicles of uncertain age. Fifty years later, E. J. Garwood found that the high range bordering Sikkim to the west of Hooker's locality was formed of thick, altered limestones containing crinoid remains, and he considered that these limestones, probably Silurian or Carboniferous in age, were the westward extension of Hooker's limestone. On the other hand, Henry Hayden, in 1907, mapped the rocks east and north of Hooker's locality and proved a sequence from Jurassic to Eocene; he suggested that Hooker's limestone might be the equivalent of one of the Jurassic limestones found by him in southern Tibet.

The actual locality of Hooker's find was not revisited until after the 1933 Mount Everest Expedition. On this occasion small collections of fossils were made which form the subject of this paper, one from Hooker's locality, another from a horizon in the Lachi Hills near by, and a third from erratic material derived from the Mount Everest Limestone Series, which includes the limestones of North Sikkim first described by Garwood. The valuable results obtained from this scanty and badly preserved material, which was collected by the present reviewer, are a tribute to the skilful way in which the modern palæontologist works, extracting much of value from very little.

In the Lachi Hills overlooking Hooker's locality, an outcrop of the highly characteristic Mount Everest Limestone, which forms the summit of Mount Everest, was found to be overlain by quartzites, shales and pebbly sandstones which were named the Lachi Series. Brachiopods from a horizon in the Lachi Series are shown by Dr. Muir-Wood to include *Marginifera himalayensis*, *Spiriferella rajah* and *Neospirifer moosakhailensis*, and a valuable discussion of the affinities and distribution of these and some other species is provided. On the basis of the brachiopod fauna, Dr. Muir-Wood shows that this fossiliferous horizon in the Lachi Series is equivalent to the Productus Shales of Spiti and the Zewan Beds of Kashmir; she also shows that it is probably of the same age as the upper Productus Limestone of the Salt Range, although of a somewhat different facies. The relation of these Tethyan deposits to the Permian succession in Russia is considered and the conclusion reached that this horizon of the Lachi Series is Upper Permian. Molusca and Bryozoa, described by Dr. Oakley, support the hypothesis of the Upper Permian age of the beds.

The few organic remains from Hooker's limestone, only a single block of which could be brought back owing to transport difficulties, indicate a probable Permian or Triassic age. The fossils include a new species of Solenopora, the first species to be described from the Permian of a genus which ranges from the Lower Palæozoic to the Jurassic. To his description Dr. Oakley appends a valuable discussion on the nature of the Solenoporaceæ, of which the algal affinities, although usually accepted, have been questioned in recent years by several authors. Dr. Oakley definitely rules out the Hydrozoa, and on the whole favours the algal view.

The thousand feet or so of the Lachi Series lying below the Upper Permian horizon consists first of pebble beds and then of shales and quartzites. Below these lies the Mount Everest Limestone Series, an important rock group of the Eastern Himalaya, the age of which has not yet been directly established. A few fossils, including immature rugose corals, indeterminate brachiopods and a new species of Straparollus collected from shales below the pebble beds are described by the authors, but they provide no precise estimate of age. Nor can the fragmentary fossils from the Mount Everest Limestone itself give any satisfactory evidence for the age of that horizon. However, the authors attempt to estimate, by means of lithological comparisons, the age of these pebble beds, which include horizons in which pebbles several inches in diameter occur in a matrix of silt grade. This unusual lithology led J. B. Auden to liken these rocks to the Blaini tillites. If this correlation be accepted, then, as Dr. Muir-Wood shows, the pebble beds would be Upper Carboniferous in age and the Lower Permian would be missing on Lachi. As a corollary the age of the Mount Everest Limestone Series would be Lower Carboniferous or even earlier.

It is considered that too much assurance has been placed in the tentative lithological correlation of the pebble beds; the authors even go so far as to state that the horizon is a glacial boulder bed (p. 59), which is certainly an overstatement, so far as present evidence goes. It would seem to the reviewer quite as probable that there is no non-sequence on Lachi, that the pebble beds are Lower Permian in age, and that the Mount Everest Limestone Series is somewhat younger than is indicated on the assumption that the pebble beds are equivalent to the Blaini tillites. Providing, however, that arguments based on the possible glacial character of the Lachi pebble beds are regarded as no more than tentative, then the authors have done a service by working out the full implications of such a hypothesis.

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* "Upper Palaeozoic Faunas of North Sikkim." By Helen M. Muir-Wood and Kenneth P. Oakley. *Palæontologica Indica*, New Series, 31, Mem. No. 1. Pp. 91+4 plates (1941).

These less secure deductions do not in any way obscure the main conclusion of the authors, that an Upper Permian horizon occurs north of the Himalaya in Sikkim. This provides a valuable *terminus ad quem* for dating the Mount Everest Limestone Series, a highly characteristic lithological unit, which should one day be a most valuable guide in unravelling the structure of the Eastern Himalaya.

L. R. WAGER.

A PROPOSED REFORMED MONETARY SYSTEM

AN interesting anonymous pamphlet designed to propose a reformed monetary system consistent with the requirements of post-war trade and economic intercourse between nations has recently been published*.

The author begins by saying that it will be indispensable after the War for nations which must have large exports in order to avoid the dislocation of their internal economies to find outlets for these exports, even if the recipients are not in a position, at any rate for the time being, to repay on a commercial basis with exports of their own. He concludes that it will be necessary to maintain control over the foreign exchanges for a period after the War, and for exports to be made on a basis which will give the exporters the alternative of receiving payment in goods or not being paid at all, as it would be clearly foolish to begin again the practice of piling up unpayable debts.

Then the author sets out proposals for the structure for a permanent post-war system of international trade. This he proposes to anchor to two forms of stabilization—stabilization of the internal price level in each country, measured in terms of the average general level of prices, and stabilization on a permanent fixed basis of the rates of exchange of the moneys of different countries. Having done this, he proposes to conduct all foreign trade by what amounts to an international clearing system, bilateral in the main but with provision for multilateral arrangements, and he suggests that all adverse balances not cleared by payment in goods to the creditor country within a period of seven years should be merely cancelled. Nations would then have no incentive to seek to export more than they are prepared to import, and would be in a position to adjust their economies to either a high or a low level of foreign trade actively.

It is clearly impossible to offer any effective criticism of these problems in a brief note. All that can be said is that the pamphlet sets forth cogently the shortcomings of the existing financial system, but slides much too easily over the difficulties inherent in either price stabilization or permanent exchange stability—much more over the difficulties involved in a combination of these two systems.

G. D. H. COLE.

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* A Twentieth Century Economic System. Pp. 60. (London: Economic Reform Club, 1941.) 6*d*.

AIR-RAID DAMAGE AND ELECTRICITY SUPPLY

RECENT articles in the *Electrical Review* disclose the steps which have been taken to overcome air-raid damage to the properties of electricity supply undertakings, and the measures taken to restore supply. Without giving away vital information to the enemy, it may be said that, of the very large number of bombs dropped during a period of twelve months, some have inevitably fallen on or near power stations. Thanks to the design of the modern power station and the special precautions taken against blast and fire, the actual damage has generally been superficial. One of the newest stations in Great Britain, for example, which received a direct hit on the boiler house roof, sustained no damage that a few bricklayers and concreters could not make good in a few weeks, and the plant itself was unscathed.

An interesting and noteworthy experience arising from raids is that in the older types of buildings, damage appears to be limited to wood-supported roofs, and it is recommended that roofing be as thin as possible. The incendiary bomb will then pierce the roof and burn harmlessly on the concrete floor below, glancing off machinery, which should be suitably protected to ensure this. In this connexion "Durasteel", which has been used for the protection of switchboards and other vital apparatus and machinery, has fully justified the claims made for it. Several instances have been observed in which valuable plant has been saved by its use, the only noticeable damage to itself being discoloration.

Though incendiary fires in substations are uncommon it is desirable, in the interests of the safety of A.F.S. personnel, that the latter should notify the undertaking if fires occur adjacent to and threatening any of its property, as the A.F.S. is not normally provided with the necessary foam apparatus for dealing with burning transformer oil and outbreaks among live gear.

The greatest amount of damage experienced has been, not unexpectedly, that caused by bombs to underground cables. Experience has shown, however, that paper insulated, lead-sheathed and armoured cable stands up to very severe damage, irrespective of voltage, one instance occurring where only the electric cables supported a damaged bridge.

Numerous instances have occurred where cables, depressed and twisted many feet below the laid level, have not failed. Examination has revealed that sometimes, though not always, the stretching of directly laid cables has been confined to the length in the crater, and has not extended to any appreciable length on either side, slack in adjacent manholes having frequently been sufficient to prevent damage to joints. Cables laid in ducts have been pulled along the duct towards the crater, joint wipes being torn away from the lead sheath, often two or three manholes away. This pulling sometimes extended for

300–400 yd., and as many as three straight-through joints in series have been pulled out, the cores occasionally being broken inside the lead sheathing.

The restoration of supply has been much simplified by the existence of the grid and by the commendable foresight shown in providing a pool of apparatus upon which undertakings may call in emergency.

Incidentally, while it is essential to restore supplies as soon as possible, this does not mean that personnel should take unnecessary risks or attempt feats beyond their powers of endurance. There is a scarcity of trained engineers and it is foolish for them to risk their lives unnecessarily during raids, particularly men fully trained in the layout of networks. It is a great mistake to rush every available man to the scene of the damage, and to have too many of them at the same spot where they might all be put out of action by a single bomb.

One mitigating feature of the widespread bombing in some districts has been that it has assisted substantially in the change-over from D.C. to A.C.

Should property be demolished and the distributor damaged or severed in a crater, supplies may be restored by temporarily pot-ending the cable ends at each side of the crater, and making alive both ways. In the event of debris preventing access to the cable in the crater, the cable may be excavated and cut at points remote from the crater and pot-ended in the same way. One undertaking has adopted the unique expedient of dropping a new section of distribution cable in the crater, filling up around with cement and making permanent joints at the ends. When the work of clearing up the crater is nearly complete, an empty duct is laid in case the cement encased cable should fail at a later date.

Another ingenious example may be mentioned, in which all the high-voltage cables of two substations were hit by high explosive bombs. In order to restore supplies, temporary cables had to be run across a wide main road clear of the crater and other services involved. The road consisted of granite sets laid on 9 in. concrete, and as time could not be spent in breaking up the wide main road, about five rows of granite sets 7 in. deep were removed, the concrete road beneath remaining undisturbed. Wooden rails (4 in. × 3 in.) were laid in the sides of the trench, and 8 in. × 3-in. boards as long as the trench width were laid across to form a wooden bridge over the five 0·20-sq. in., 6·6 kv. cables required. The top boards were covered with earth, and main-road traffic passed over this run for many weeks. Perhaps even more effective is the digging of the smallest possible trench, running in armoured cable, and filling in solid with cement.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public.)

Monday, February 9

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 3 p.m.—Sir Malcolm Watson: "Geographical Aspects of Malaria".

Tuesday, February 10

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.30 p.m.—Short Contributions on Problems in Illuminating Engineering of the Present Time and in Post War Reconstruction.

Wednesday, February 11

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mrs. Darcy Braddell: "The Post-War Home—its Interior and Equipment". 5: "Common Sense in Furniture Design".

Pharmaceutical Society of Great Britain (at 17 Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Dr. Philip Hamill: "Prescribing in War-Time".

Physical Society (Colour Group) (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Annual General Meeting. Dr. W. D. Wright: "Research on Colour Physics at South Kensington, 1877–1942".

Society of Chemical Industry (Food Group) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. N. W. Pirie, Dr. T. Moore, and others: "Green Leaves as a Source of Protein and other Nutrients".

Thursday, February 12

Royal Institution (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Dr. C. H. Waddington: "Some Biological Discoveries of Practical Importance".*

Friday, February 13

Royal Society of Arts (India and Burma Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. J. Gibson: "The Story of Lac".

Royal Astronomical Society (at Burlington House, Piccadilly London, W.1), at 4.30 p.m.—Anniversary Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Headmaster—The Clerk to the Governors, Rutlish School, Merton, London, S.W.19 (March 14).

Teacher of Mathematics (man or woman)—The Principal, South-West Essex Technical College, Forest Road, Walthamstow, London, E.17.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Recommendations for the Computation of Heat Requirements for Buildings: as embodied in the Guide to Current Practice issued to its Members by the Institution of Heating and Ventilating Engineers. Pp. iii+41. (London: Institution of Heating and Ventilating Engineers.) 1*s.* 9*d.* [191

Other Countries

Cornell University: Agricultural Experiment Station. Bulletin 753: Further Studies of the Influence of Different Levels of Fat Intake upon Milk Secretion. By L. A. Maynard, J. K. Loosli and C. M. McCay. Pp. 18. Bulletin 755: Soil and Pasture Management for Long Island, New York. By A. F. Gustafson and D. B. Johnstone-Wallace. Pp. 44. Bulletin 757: The Alfalfa Snout Beetle, its Control and Suppression. By Charles E. Palm, Charles Lincoln and A. B. Buchholz. Pp. 50. Bulletin 758: Clover Leafhopper (*Aceratagallia sanguinolenta* Prov.). By T. C. Watkins. Pp. 24. Bulletin 759: Costs and Returns for the Cabbage Enterprise, 1938 and 1939. By R. W. Hoecker. Pp. 60. Bulletin 760: Rural Public-Welfare Administration and Finance in New York. By E. A. Lutz. Pp. 72. Bulletin 761: Prices of Apple Varieties as a Factor in Variety Selection. By M. D. Woodin. Pp. 20. Memoir 239: Price Flexibility and Price Movements in the United States and other Countries. By Mark T. Buchanan. Pp. 25. Memoir 238: The Influence of Age and Rate of Breeding upon the Ability of the Female Rat to reproduce and raise Young. By S. A. Asdell, R. Bogart and G. Sperling. Pp. 26. Memoir 236: Biology and Ecology of the Alfalfa Snout Beetle. By Charles Lincoln and Charles E. Palm. Pp. 45. (Ithaca, N.Y.: Cornell University.) [11

Southern Rhodesia. Memoirs of the Department of Agriculture, No. 3: Further Studies in the Physiology and Behaviour of *Glossina morsitans*, Westw. By Rupert W. Jack. Pp. iii+56. (Salisbury: Government Stationery Office.) [11

Cooper Union for the Advancement of Science and Art. Eighty-second Annual Report, July 1, 1941. Pp. 162. (New York: Cooper Union.) [21

The Physical State of the Upper Atmosphere. By B. Haurwitz. (Reprinted from the *Journal of the Royal Astronomical Society of Canada*, October 1936–February 1937, with Addition October 1941.) Pp. viii+96. (Toronto: Royal Astronomical Society of Canada.) 75 cents. [61

U.S. Office of Education: Federal Security Agency. Vocational Division Bulletin No. 209 (Agricultural Series No. 54): Building Electrical Equipment for the Farm. By W. A. Ross, W. P. Beard, Jay Deiss and Lee C. Prickett. Pp. vi+87. 20 cents. Vocational Division Bulletin No. 213 (Home Economics Education Series No. 24): Home Economics in Public High Schools, 1938–39. Pp. vii+114. 20 cents. (Washington, D.C.: Government Printing Office.) [61

Commonwealth of Australia: Council for Scientific and Industrial Research. Pamphlet No. 109: Studies of the Physiology and Toxicology of Blowflies, 8: Rate of Ammonia Production by Larvæ of *Lucilia cuprina* and its Distribution in this Insect, 9: The Enzymes Responsible for Ammonia Production by Larvæ of *Lucilia cuprina*. By F. G. Lennox. Pp. 64. (Melbourne: Government Printer.) [61

The Measurement of Self-Diffusion in Zinc: a Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. By Floyd R. Banks. Pp. 8. (Philadelphia: University of Pennsylvania.) [91

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WELFARE AND TRAINING OF YOUTH

THE notable speech of Mr. R. A. Butler, President of the Board of Education, to a National Defence Public Interest Committee on December 10 is one of the indications which appear from time to time that the essential part of education both now and later has been realized. Mr. Butler claimed that his department is becoming recognized as the great national department of State for the training of the young. He gave the assurance that no further inroads on the teaching profession are contemplated at present, and he hopes the situation will never demand them. He viewed the registration of boys and girls of 16–18 years of age under the new National Service Act as a step towards building the arch from 14 to 18, and local authorities are being asked to do all they can to increase the facilities for training and service for boys and girls of 14–16.

These steps are not intended to take the place of the Fisher plan for continuation schools, but the scheme should accustom young people to the idea that in these early years the path to manhood and womanhood lies through knowledge and, broadly, citizenship. Mr. Butler indeed linked the scheme up with the idea of a new social charter, with its Bill of Duties as the counterpart of the Bill of Rights, which has been voiced in several quarters both in Great Britain and in the United States. From early youth, he said, the young citizen should learn that there must be acknowledged duties to be performed by the individual for the community, which should confer certain rights and privileges in return.

Mr. Butler's speech is the more encouraging to those who believe that the care of the children is the concern of the nation and that the welfare and training of youth are matters of supreme importance at all times because of the comparative neglect of education in the attention which has already been focused upon reconstruction. Despite the general recognition that the education of public opinion must be a prelude to effective action in almost every field, that has been viewed as mainly a matter of preparing opinion for change through some measure of adult education. There has been little indication of the conception of the education of the adolescent as part of a grand design embracing every aspect of life. The Minister of Labour has indeed already spoken in similar terms of the plans being initiated for the training of young people, and there is real promise in the evidence that Mr. Bevin and Mr. Butler are working together. Such co-operation should create the links between technical training and industry and commerce of which Mr. Butler spoke, and which are essential in the interests of both the individual and the nation.

Equally vital is the attention to voluntary training which will accustom young people, as Mr. Butler said, to the idea that in their early years the path to citizenship lies through knowledge, work and service. Inspired leadership should turn the eagerness of the juveniles to play their part in the war effort into channels which will fit them to play an equally or even more important part in the tasks of reconstruction which lie beyond. It is this vision of the future of education that is pregnant with possibilities in reconstruction, and a notable article in the admirable series on our problems of reconstruction running through the *Round Table*, which is concerned with the future of education, has particular claims on the attention of the scientific worker.

Directing attention to the part which science—in the Latin sense of the word and not the narrow meaning to which we usually restrict it—has played in stimulating the educational developments of the last seventy years, the *Round Table* points out that in a world where life is increasingly based on knowledge, the uneducated man is useless or dangerous. He is no less incompetent as a soldier or citizen than as an engineer. The need to train the intelligence of all, in order to live in a civilization where as much intelligence as possible is required, sufficiently explains the recent development of education and why such development must continue.

Some lines of further development have been indicated in the Hadow and in the Spens Reports, and the creation of a democracy which can enjoy and sustain the new order of society foreshadowed in the Atlantic Charter depends on our implementing such proposals. That democracy cannot be created if education for the vast majority stops at fourteen, or if we fail to give them the right kind of education. The question of the content of education and how it is to be given is the unsolved educational problem of to-day.

In any scheme of national education we must provide, as at present, for two great classes—the few and the many. The composition of the first class will no longer be the same as at present, for it should be recruited from the whole nation, without distinction of birth or wealth, and should consist of those whom the community chooses to be its leaders because of their fitness to lead. The selection of this class will, in fact, be one of the most difficult problems for society, involving as it does one of the gravest dangers to education. Already the competitive examination system is corrupting the disinterestedness which is the essence of all good education and without which liberal education is impossible.

If we can deal with this problem and at the same time remove the grave defect of our newer universities emphasized in two recent books—that they teach rather than educate—we have still to face the larger problem of the higher education of the many. Here everything remains to be done, and no one can suppose that the mere implementing of the provisions of the Fisher Act will provide a solution. At the age of fifteen or sixteen education has only commenced; it has certainly not reached its goal. Education is intended to be used in life, and its meaning and importance cannot be apparent to an adolescent or even to an undergraduate who has seen nothing of life. It is this fact that gives value to part-time education for the adolescent, and to adult education, which gives men and women engaged in the ordinary business of life the opportunity to think about it systematically.

The article in the *Round Table* suggests that the time has come for the lessons learnt during the last forty years through the experience of the Workers' Educational Association to be applied to other sections of the community, as has already been done elsewhere in Europe. While, however, such experiments deserve close study, and notably the Danish People's High School, we must beware of merely copying other systems. Education should be inductive and clinical, based on a study of the 'patients', as well as deductive, and if we are to achieve that essential element in post-war reconstruction, as educated people, we must bring imaginative insight to bear on our problem, creative thought as well as administrative ability and energy. We must plan our educational system not merely to include refresher courses for teachers, medical men, scientific workers and other professional or specialist workers, but also to keep the human mind of the whole people growing and alive, giving them an opportunity of systematic study and a chance to think methodically about life when they have far more to think about than they can have at school or university.

Leaving on one side for the present the question of the part which the university and the secondary school have to play in such a frame-work of education, with its emphasis on education rather than instruction or teaching, there must be considered these three elements which are essential in any education adequate to the needs of to-day. All men need to make a living and the best that conditions permit. All have to live in a society and all need a scale of values, a sense of what is first-rate, in life as a whole, and so far as is possible, in its many provinces. To meet these needs education must provide a vocational, a social and a spiritual element, and it must do this not for a limited class but, in different ways, for every citizen.

Of the vocational element it need only be emphasized here that a society should give its educated members not only specialist knowledge but also some perception of the general conditions and possibilities of modern civilization, and a sense of the importance and uses of the techniques essential to it. It is a knowledge of science in this sense, indeed, that should form part of the education of every citizen and not of the specialist alone, just as it is the wide vision and sense of perspective implied in such a general conception that should correct the narrow specialism which has often warped the development of the scientific worker himself and hindered his participation in the work of the community. To that, indeed, a fuller corrective is the social or political education of which, largely under the pressure of the competitive examination system, he has so often been deprived.

Some training in the art of governing and, still more, of being governed; in independence and in respect for authority; individuality and team-work; self-assertion and self-discipline and self-sacrifice; initiative and subordination: the value of these becomes more apparent with every passing day of war. Their value will be no less when the nation turns once more to the tasks of peace, and they are an essential part of the education of every citizen, whether he occupies a scientific, technical or administrative position or any other, just as some understanding of general science in the broad sense should make up part of his equipment for living in this modern world. The registration of boys and girls of 16–18 under the National Service Act can serve no more useful purpose than that of implementing this education in citizenship which certain institutions such as the Scout movement and the Youth Groups themselves are already imparting.

If we must discover new ways or forms for extending social education it is important that we should utilize to the full existing agencies and the foundations already laid. The *Round Table* article emphasizes the value of the public, or as it should be termed the residential, school, in training in the principles and practice of living in a community. This opportunity must not be thrown away, but the residential school, coming under the ultimate, though not necessarily direct, control of the Board of Education, should be open to every class in the community, and the right to entry should be based on merit, assessed not merely in terms of intellectual ability but also of character and personality. The further opportunities afforded by the growth of school camps, the development of the Youth Movement and of any form of national service or conscription which may persist after the War must also be seized for this education in citizenship and to promote mutual understanding between the different classes of society and thus to strengthen the national unity.

The third element is the most neglected and at the same time the most important and most difficult branch of education. Upon this, which for want of a better word may be termed spiritual education, the quality of our civilization, its standards, its sense of values depend. Without it we shall lack the driving force to carry through any adequate programme of reconstruction, national or international, which will make it endure. Knowledge or science, indispensable as they are in the framing of wise and impartial measures, are not enough. They cannot supply that habitual vision of greatness which, in Prof. Whitehead's phrase, is essential for moral education. They will not supply the driving force, the right standards, values and ideals without which no enduring social order can be built.

Difficult as this task must be, we must not be content with any system of education which does not give men both the chance of seeing the vision of greatness and of practising the virtues. New sources of that vision of greatness may need to be, and indeed are being, discovered. They can, indeed, be found in the quest of truth and the highest traditions of science, as in other fields of human activity, the Greek and Latin classics and in the Christian ideal and tradition. It must never be forgotten that science, economics and sociology can do no more than provide the framework of our society and satisfy its material needs. It is the vision and sense of values that spiritual education imparts that hold society together, supply its driving force and preservative against corruption. No pre-occupation, therefore, can excuse failure to place the spiritual element first in our system and to ensure that the vision of greatness from whatever sources it springs is available to all and not merely to the privileged few. The discussion on Science and the World Mind at the Conference on Science and World Order demonstrated that men of science are already thinking deeply about these problems, and they will be grateful for the evidence that Mr. Butler no less than his predecessor at the Board of Education is giving such close attention to the fundamental problem in all reconstruction—that of developing citizens, young or old, who can first reconstruct themselves.

PROGRESS OF GEOMAGNETISM

Geomagnetism
By Prof. Sydney Chapman and Prof. Julius Bartels. (International Series of Monographs on Physics.) Vol. 1: Geomagnetic and Related Phenomena. Pp. xxviii+542. Vol. 2: Analysis of the Data, and Physical Theories. Pp. x+543–1050. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 63*s*. net.

"THE earth itself is a great magnet." So wrote Dr. William Gilbert, fellow of St. John's College, Cambridge, nearly three and a half centuries ago. The detailed geographical determination of the nature of that magnetism, and the attempts to identify its origin, have since attracted much effort and friendly international co-operation. But, substantially, Gilbert's challenging statement still remains something of a mystery. For while much is now known of the origin of the small, but significant, periodic components of the earth's magnetic field, the genesis of the much greater quasi-permanent components continues unexplained.

The fundamental problem of the earth's main field is not rendered easier by the fact that that field is slowly changing. It is true that it does not change much in a human life-time, but, within astronomical and geological scales of time, the variation must be considered very rapid indeed. The direction of the magnetic north in England has, for example, changed by about 30° since Gilbert's time, while there are certain places on the earth's surface where the intensity of the magnetic field has altered by about 10 per cent during the last half-century. As a result of the early analyses of Gauss and Schmidt, it was established that the greater part of the earth's external magnetic field is due to causes operating beneath its surface. In fact, the earth behaves very much like a uniformly magnetized sphere with its magnetic axis making an angle of $11\frac{1}{2}°$ with the geographical axis of rotation. But the average intensity of magnetization has to be regarded as very much greater than that of the ordinary crustal rocks so far examined. To account for this is the central problem of geomagnetism.

Fortunately it is only the problem of the semi-permanent magnetism of the earth which proves so intractable. The transient changes of magnetism, which are to be noted during a period of time measured in hours, are not so unaccountable. They are known to be due to causes operating outside the earth's surface, as was also shown by the Gauss-Schuster analysis. They are superposed on the slow secular variations of the main field and may be divided into two classes: the regular solar and lunar diurnal variations and the more erratic variations characterized as magnetic storms. Both classes of variations are found to vary in intensity through the sunspot cycle.

Since, so far as we know, magnetic matter does not exist in the space round the earth, the primary part of these transient magnetic changes is probably due to electric currents. According to the bold speculation of Balfour Stewart, advanced in 1882, such currents are to be attributed to dynamo action in the earth's upper atmosphere. Now the essential feature of a dynamo is that it contains an electrical conductor moving in a magnetic field. The magnetic field is already provided by the earth, and Balfour Stewart suggested that the electric conductor is the rarefied upper atmosphere itself, which is made to move periodically across the magnetic field by the tidal and thermal action of the sun and the moon. That Balfour Stewart was correct in the essential postulates of his theory has been proved in experiments carried out in Great Britain. Thus, radio experiments in 1925 showed that the upper atmosphere is permanently ionized to a marked degree, while, twelve years later, similar experiments disclosed quite unexpectedly large tidal motions of that conductor resulting from the gratitational influence of the moon. Further evidence showing the connexion between ionospheric events and the ephemeral changes of terrestrial magnetism has been obtained in the study of ionospheric phenomena through the sunspot cycle. Radio experiments have shown that, at certain levels, the electrical conductivity of the upper atmosphere increases by about 50–60 per cent from sunspot minimum to sunspot maximum. During the same period there is a corresponding and equal enhancement of the solar diurnal variation of the earth's magnetism. By the same radio technique it has been further shown that this remarkable change in the ionosphere is caused by what may be as much as a 150 per cent increase in solar ultra-violet radiation.

But, although great progress has been made in disclosing the nature and identifying the causes of these transient variations of the earth's magnetism in work carried out since the nineteenth century, there has not hitherto been available any up-to-date account of such recent progress. In this book, "Geomagnetism", we have, however, the most satisfying fulfilment of this need. Those who know the subject would have chosen no other authors for its *magnum opus*. In zealous devotion to the subject over a period of many years, each has enriched our knowledge of both the nature and significance of the temporal magnetic variations; while Prof. Chapman's theoretical studies of ionized layer formation have greatly assisted those ionospheric physicists who have used the radio wave as a supplementary tool in exploring the nature of the upper atmospheric dynamo.

The two substantial volumes into which the work is divided cover the subject both widely and closely. The first volume contains an exposition of the magnetic facts, as gleaned from years of observation, and also includes briefer, but up-to-date, accounts of related subjects such as earth currents, auroral phenomena and ionospheric characteristics. The second volume is in two parts. In the first there is a most illuminating description of the mathematical apparatus which has been devised, much of it by the authors themselves, for use in the analysis of such complicated phenomena as result from the simultaneous influence of the sun and moon on the terrestrial atmosphere. In the second part of the volume there are expounded the physical theories which have been evolved to explain the facts as more simply revealed by such mathematical analysis. The two volumes, which are generously illustrated both by diagrams and plates, together include about a thousand pages of text and are very well furnished with bibliography and indexes. Particularly useful to the research worker will also be the tables of long series of magnetic and solar data brought up to the year 1937, with convenient spaces for the inclusion of later values.

Distinguished and scholarly in treatment, "Geomagnetism" will assuredly become a classic. Its publication has instantly increased the already considerable debt which workers in this and allied fields already owe to its two authors.

E. V. Appleton.

RAW MATERIALS

Those Raw Materials

An Introduction to the Study of Raw Materials. By C. A. Ward. Pp. 392. (London: George Allen and Unwin, Ltd., 1941.) 15*s*. net.

DESCARTES, it will be remembered, resolved to seek happiness by limiting his desires rather than by attempting to satisfy them, thus setting himself against the grain of common human endeavour. In these times, thanks to science, invention and advertising, our needs have multiplied like the seed of Abraham, and although some of them appear superfluous, or even harmful, many can be ethically justified on the score of self-preservation or self-development.

Very early man seems to have thrived on a dietary of berries, eggs and shellfish, and on clothing made of leaves and of the bark of trees; his heirs have scoured land and sea to find and exploit materials that administer to their well-being, and when frustrated they have fought—and still fight—for possession or control of them. The spirit of adventure, now believed to be on the decline, and the instinct of acquisition, still very much to the fore, have brought within range an almost untold wealth of raw materials which, when used rightly, add to the sum of human happiness, but, when used wrongly, lead to envy, hatred, masochism, sadism, and their sequel—war. Unfortunately, though there is seeming abundance for all, the will to dominate and possess has operated to alienate much of the world's natural wealth for the possession and enjoyment of the few, and this process has been assisted by the extremely haphazard way in which raw materials are distributed over the earth's surface (air, and to some extent water, excepted). That is not the fault of man. Nature—personified as a woman, somewhat unchivalrously to the fair sex—does not, like the moon, always show the same face to beholders. She can be exceeding fair, but she can be red in tooth and claw; generally she seems to be supremely indifferent to human welfare: as callous as was Herod to the Holy Innocents, or is Hitler to the Jews. The teleological doctrine, which *reads into* Nature a benevolent purpose, has now joined the scrap-heap of discarded wish fulfilments, and virile folk have come to realize that man is largely the master of his own fate: it is he alone who can smooth out some of those grosser inequalities of natural wealth and human endowment that undermine men's sense of security and lead to bitterness and strife. The Atlantic Charter has done well in postulating equal access to raw materials as a *sine quâ non* of a lasting peace.

Mr. Ward's introduction to the study of raw materials gives a good idea of their range and their uses; except when he wanders off into electronic theory, his treatment is entirely factual, consisting mainly of short notes and brief descriptions. Its main defect is that, with the exception of the chapters on coal and petroleum, it ignores the very important economic background; there is no discussion of rates of exhaustion and probable lives of mineral deposits, of improved means of extraction and conservation, or of geographical distribution in relation to marketing; and there is no map. On the other hand, much space is devoted to "metallurgical treatments as applied in the final preparation of metals", and to materials which cannot be accurately classed as 'raw'. Thus he devotes two chapters to chemical products, among which are included many intermediate substances, as well as finished products like dyestuffs, explosives, lead compounds, synthetic rubber and artificial silks. But little consideration is given to those ubiquitous raw materials, atmospheric nitrogen and oxygen, and water, which in recent times have been used more and more by the chemical industry. The future importance of the exhaustion of supplies of rock phosphate is ignored, as also are the possibilities of using sea-water as a source of commercial magnesium, potassium and bromine, and clay as a source of aluminium.

Criticism must also be extended to certain defects in literary style. Sir A. Quiller-Couch's lectures on "The Art of Writing" are still largely ignored by technical writers. Among the stylistic sins he denounced was the use of circumlocutory and redundant expressions, like 'in the case of', 'in connexion with', and 'as regards'. In the book under review the first of these occurs hundreds of times, and 'in the very first place' is a frequent substitute for 'first' or 'firstly'. The schoolboy error of referring to one thing, or to the last of three or four things, as 'the latter', disfigures many sentences. The title also savours of 'journalese', and in conformity with it the author overdoes the journalistic 'while', reminding one of A. P. Herbert's example: "The curate read the lessons while the vicar preached the sermon".

Books on scientific and technical subjects intended for the general reader are notoriously difficult to write. The first consideration for an author is to 'remember the reader' and adapt his style to the class of reader he has in mind. For the reason just mentioned, Mr. Ward's book cannot be recommended for use in schools, and the serious student will find it too fragmentary and too lacking in insight to meet his purpose. It will probably appeal most to the middle-aged man who wishes to rub up and extend the knowledge he acquired long ago; he will find it especially useful in reading company reports and similar 'literature'. One cannot help feeling that the author has lost an opportunity to write a book of real human interest, one that touches life at many points besides the purely technical. When he is asked to revise the present edition, perhaps he will try to convert his own 'raw material' into a finished product.

E. H. TRIPP.

INDUSTRY AND ITS HAZARDS

The Analytical Chemistry of Industrial Poisons, Hazards and Solvents

By Dr. Morris B. Jacobs. (Chemical Analysis, Vol. 1.) Pp. xviii+661. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1941.) 7 dollars; 42*s*.

AT the present time, when the future of Great Britain and the very lives of our people depend upon the output of industry, the safeguarding of the health of industrial workers is a matter of supreme importance. We are prepared, therefore, to welcome any contribution which may be a real help in improving the health of the worker or combating any condition which may be toxicological or otherwise deleterious. Although there is quite a number of publications dealing with industrial medicine and hygiene, there has been comparatively little published in connexion with the analytical chemistry of industrial poisons. This book attempts to fill this gap and though the treatment of the subject is somewhat uneven, and though there are a good many gaps, it does give something of value in dealing with the particular hazards which are met with in industry.

The preliminary chapters are devoted to sampling procedure and practice, and the methods given for obtaining samples of dust and gases are very good and helpful, as are the methods of dust and gas analysis. In the chapters dealing with the metallic poisons, the methods adopted are clearly set forth, but there is often too much descriptive matter for the skilled chemist, and not enough for the person who is not accustomed to carrying out the particular tests described. One might also question the value of the clinical and physiological information which is given. It is in general correct, but it is insufficient to be of any particular use and it is difficult to ascertain to whom it might appeal.

Industrial solvents and their examination are carefully and adequately described. The author in his colorimetric tests does not appear to use the colorimeter, but depends on using standard colours and matching them by the eye. There is a condensed but useful chapter on the gases of warfare; tables of concentration limits of exposure for fumes, vapours and dusts; the toxicity data of various gases and vapours in the atmosphere, and the limits, inflammability and explosive range of substances likely to be met with in industry.

There is a fairly wide and up-to-date bibliography, mainly referring to publications in the United States, but this is not unexpected as a great deal of the work in industrial toxicology has been carried out in that country.

The index could be greatly improved, and where a number of references are given, some indication should be made as to the more important ones by stressing them in darker type or some other convenient method.

In future editions the author would do well to use the initial or Christian name of the various authors in his references, for without this it is almost impossible to obtain any idea of the authorship of a particular paper, especially if the name is a common one.

Taking it all round, the book is sound, and should be of service to those dealing with industrial medicine and industrial toxicology.

ROGER JOSEPH BOSCOVICH

Roger Boscovich, S.J. (1711-1787)
Forerunner of Modern Physical Theories. By H. V. Gill. Pp. xviii+76. (Dublin: M. H. Gill and Son, Ltd., 1941.) 7*s*. 6*d*.

THOUGH the author speaks (p. 64) of "Newton and other scientists of the time, including Boscovich" as though they were roughly contemporary, this is clearly misleading; for Newton was nearly seventy when Boscovich was born at Dubrovnik (Ragusa) in Dalmatia. This means that one was a man of the seventeenth, the other of the eighteenth century. Similarly, when at the outset of his "Theoria Philosophiae Naturalis", Boscovich asserts that his own system is midway between that of Leibniz and that of Newton, it may be suspected that this is true in the sense that, but for the matter of dates, both would have expressed equal disagreement with his ideas. It is, in fact, hard to understand what he did mean, for the particles of his system never came into mutual contact and they are not subject to the action of a surrounding medium. Yet Boscovich emphatically denied the possibility of action at a distance.

In spite of this inconsistency in his natural philosophy, Boscovich was a voluminous writer who achieved a considerable reputation in his lifetime and even now cannot be dismissed altogether lightly. In order to understand these facts it is necessary to have a clear account of the physical theory which Boscovich developed. But the present small work scarcely touches the history or explains why the theory took the shape it did, or in what way it was founded on the contemplation of experimental facts. In the absence of this background the system seems purely intuitive and to owe its power of adaptation to later problems to good fortune rather than to intrinsic merit.

Indeed the origin of this eighteenth century system seems to have been in the main metaphysical. Its greatest influence was exercised in Great Britain, and particularly in Scotland. In this way it came to the attention of Lord Kelvin, who found a use for it in his later work on elasticity and molecular physics. Similarly J. J. Thomson, when presented with the puzzling properties of his newly discovered electron, had recourse to the ideas of Boscovich. Now again Fr. Gill recalls the Boscovichian corpuscle and sets it to the task of explaining the interference and diffraction of light, the Bohr atom and even wave mechanics in a primitive form. More than this, Boscovich had some clear ideas of the principle of relativity as it involves the perception of scale and orientation. His view of space and time was interesting, though clearly derived to a great extent from the Newtonian theory of fluxions.

The Boscovichian particle is an infinitesimal centre surrounded by a field of force which is alternately an attraction and a repulsion at different close distances, ultimately becoming a positive attraction of the normal gravitational type. Further than this the nature of the particle is undefined, and so it makes a capital plaything for the physicist. But more is wanted to establish a scientific reputation on a sound foundation, and contacts with the past are even more important than contacts with the future.

Hence it may be regretted that here so slight a sketch of the life and character of Boscovich has been included. Yet, if the object was to present a scientific hero, it may have been wise. In truth, Boscovich seems to have been spoilt by success in early life. His character was warped by vanity, egotism and petulance; finally, disappointed with the measure of appreciation which came to him, he became the prey of melancholy and before his death sank into fits of madness. Reverting to the practice of an earlier age, Boscovich wrote a long work, "De Solis et Lunæ Defectibus", a synopsis of astronomy in verse, which Delambre described as uninstructive to an astronomer and unintelligible to anybody else. It is hard without proof to accept the legend of greatness. In some ways Boscovich seems a survival from an age long past rather than a forward-looking man of the eighteenth century. For that century had its really great men, and Boscovich can scarcely be reckoned of their company.

H. C. PLUMMER.

NEWTONIAN ATTRACTION

An Introduction to the Theory of Newtonian Attraction
By A. S. Ramsey. Pp. ix+184. (Cambridge: At the University Press, 1940.) 10*s*. 6*d*. net.

THE preface states that this book was written at the suggestion of some students who were unable to find a book on the subject suitable for their requirements. The seven chapters deal with preliminary mathematics; gravitational attraction and potential, simple applications; attraction and potential internal points, spheres; theorems of Laplace, Poisson and Gauss, general theory; Green's theorem; harmonic functions; attraction of ellipsoids.

In writing an account of a branch of applied mathematics in which the subject-matter has long since been stabilized, an author can still choose his method of presentation, and it is interesting to see that in the first chapter the reader is introduced to vector methods. With the vector notation established, one rather regrets that the matter is not pushed to a conclusion with the introduction of Gauss's general theorem in the symbolic form

$$\int n\,X\,dS = \int \nabla\,X\,dv$$

for the relation between surface and volume integrals. From this form flow the various particular cases of this theorem and Green's theorem. There is the added advantage that the emphasis is thus laid on a statement which is of general application to potential theory whether in gravitation, electricity, magnetism, or hydrodynamics. Indeed, the student of any one of these subjects is seldom forcibly presented with a clear picture showing how much belongs simply to general mathematics and how much to the particular subject which he is studying. Gauss's normal induction theorem and Poisson's equation may be cited as instances.

The book as a whole is intended for students taking an honours course, but the needs of the student reading for a pass degree are not forgotten. The author writes with the clarity and flair for exposition to which readers of his other text-books are accustomed. There are numerous examples at the end of each chapter, many taken from Cambridge and London papers, the easier examples being divided from the more difficult. The book completes the series on mechanics which the author has produced in recent years and takes a worthy place among them.

L. M. MILNE-THOMSON.

A Laboratory Manual of Electricity and Magnetism

By Leonard B. Loeb. Revised edition. Pp. xii+122+112 Experiment Data Sheets. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1941.) 22*s.* 6*d.* net.

THE author raises the old controversy about laboratory work in teaching: Should the student be confronted with a set of apparatus to do an experiment with a title, left with the minimum of prompting to work out the procedure and results to be obtained, and then be given a week or two to write the work up in his own way for subsequent correction by authority, or should he be persuaded to read up previously from specific instructions exactly what he has to do, what theory he is supposed to imbibe for the proper assimilation of the scientific work performed, be given a printed form to fill in with the stated observations and indicated calculations, and so close the deal within a specified laboratory time? Supposing that the latter is the correct procedure, the author could scarcely be bettered in working out a requisite plan. He claims that the hour given to private study, with printed relevant theory (because no course of laboratory work can keep in step with lectures), including pictorial diagrams of connexions (which, we must admit, we had thought had faded out of text-books long ago), before being confronted with the apparatus, leads to a greater efficiency in exercising the student's mind and a more speedy implantment of useful scientific principles. The scheme was developed to avoid the misuse of heredity principles in the recording of experimental work among students.

The experiments in elementary physics are well selected, but they would certainly have been done by scientific students before they reach college in Great Britain. The data sheets, of which several sets are appended, are also impressive. Nevertheless, one feels that the regimentation here presented is a line of least resistance to meet time-table pressure and inadequate laboratory facilities. If it produces the required results, how are these results measured?

L. E. C. H.

Wolf Child and Human Child

The Life History of Kamala, the Wolf Girl. Based on the Diary Account of a Child who was reared by a Wolf and who then lived for Nine Years in the Orphanage of Midnapore in the Province of Bengal. By Dr. Arnold Gesell. Pp. xv+95+8 plates. (London: Methuen and Co., Ltd., 1941.) 6*s.* net.

DR. ARNOLD GESELL has given here a psychological appreciation of the effect on a human child of her transfer in infancy from a human to a lupine family, and of her retransfer after eight or nine years to a human one, based upon the story of an Indian girl recovered in 1920 from wolves. The full story was recorded in a diary kept by the Rev. J. A. L. Singh, under whose care she spent the next nine years, and is to be published by Prof. Zingg of Denver University. Dr. Gesell's account therefore suffers from being based on facts not completely accessible to the reader. In some respects it is hypothetical; we are given a reconstruction of Kamala's unknown infancy and of her eight years with wolves. Some such imaginative reconstruction is probably necessary to the development of Dr. Gesell's theme, which is the interaction of nurture and nature in the formation of culture, and the powers of adaptation, particularly to psychological and cultural environment, of the normal human child, but his approach could have been more strictly scientific and less literary. Any judgment on the facts upon which Dr. Gesell relies would be out of place before the publication of the diary and details which Prof. Zingg is preparing. It will be awaited with no little interest by the readers of Dr. Gesell's book, which will prove, if the facts can be accepted, an important contribution to the study of child psychology and the transmission of culture.

Waves

A Mathematical Account of the Common Types of Wave Motion. By Dr. C. A. Coulson. (University Mathematical Texts.) Pp. xii+156. (Edinburgh and London: Oliver and Boyd, 1941.) 5*s.* net.

THIS book, intended for honours students of mathematics or physics in the final year of their degree course, gives an elementary account of many different types of wave motion. The first chapter contains the fundamental differential equation and its most important types of solution. Chapters ii–v deal with waves in strings, membranes, bars and liquids. Chapter vi is concerned with sound waves, and Chapter vii with electric waves. Finally, Chapter viii returns to general considerations, including the Doppler effect, beats, group velocity, wave packets, Fresnel's principle, and the theory of retarded potential. Each chapter contains a set of important and interesting problems, to which the answers are given. Lack of space is responsible for the omission of elastic waves in continuous media and of radiation from aerials, and some of the work is unduly condensed, in particular the solution of the fundamental equation on p. 7. The book as a whole is very good, and supplies a surprisingly large amount of information in a small compass and at a low price.

Functions of a Complex Variable

With Applications. By E. G. Phillips. (University Mathematical Texts.) Pp. xi+140. (London and Edinburgh: Oliver and Boyd, 1940.) 4*s.* 6*d.* net.

THIS pleasant and moderately priced little book forms an excellent introduction to the complex variable. It is written in a brisk and lucid style, and may be confidently recommended to students of pure or applied mathematics. It will appeal in particular to those who wish to understand the mechanism of conformal transformation. The titles of the five chapters are: functions of a complex variable; conformal representation; some special transformations; complex integral calculus; calculus of residues.

L. M. M.-T.

Physics for Engineers

By Sir Ambrose Fleming. Pp. xii+232. (London: George Newnes, Ltd., 1941.) 7*s.* 6*d.* net.

SUCH a wide field can be covered only sketchily in so few pages. Nevertheless, many fundamental principles are outlined and historically traced, with references to sources and proofs. The symbols are not entirely consistent, or in accordance with international standardization, but their meaning is always clear. The value for the student is the historical perspective he can profitably have induced in him and the insistence of the correct derivation of the units he habitually uses.

L. E. C. H.

FEEDING POST-WAR EUROPE

By DR. GEOFFREY BOURNE

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IN the Atlantic Charter one of the primary post-war objects of the British Empire and the United States is that of freeing the peoples of the world from want. Much has been said and written of plans for post-war reconstruction, and of these that of feeding Europe must be put into operation the moment the War ends, and, unless it is provided for, a situation might well develop which will become completely out of hand.

The problem of feeding Europe after the War is really a dual one. First we must have supplies of the right foods which can be rushed to Europe as soon as hostilities cease. Then, secondly, we must plan for the continued feeding of Europe; and that means planning not only European, but also world agriculture. This latter problem was brilliantly discussed by Sir John Orr at the British Association Conference on Science and World Order last September.

Here it is proposed to deal with the more immediate problem: What foods must the British Empire and the United States hold in readiness to rush to Europe with whatever shipping they can beg, borrow, or happen to have left themselves when the War ends? But before we discuss this matter it is necessary to review the present food position of the various countries of Europe and attempt to predict the direction which food deficiencies will take.

The population of Europe can be divided broadly into two groups of people: the peasant population and the townspeople. The peasants will probably not suffer any serious food deficiency whatever the length of the War. They are the producers, and it is difficult for any nation to ration severely those who produce the food. It is the urban population who will suffer. Not only is food production lowered and imports reduced, in some cases to practically nothing, but in many countries such as Italy, France and Belgium the peasant is withholding grain which might have been sent to feed people in the towns and instead feeding it to pigs and poultry, which sell at considerable profit on the 'black market'. In each country there is also a small well-to-do section which is unaffected by dietary stringencies. These are the people who patronize the black markets, or the hotels and restaurants which do so, or who are able to make up their dietary requirements with the aid of expensive unrationed foods.

Black markets thrive in all the occupied countries, but some are worse than others. Belgium has the biggest black market in Europe. It was so bad that Germany refused to give any help to that country until the Belgian authorities assumed control over all the essential foodstuffs. During 1940 and 1941 huge hoards of black market food were seized from the various restaurants and shops. Even bread is sold on the Belgian black market, and there are reports that potato skins have been sold there too. Black markets closely rivalling that of Belgium exist also in Luxemburg, France and Italy.

Bread is rationed in all the occupied countries and in Germany itself. In some countries where the allowance is generous there is little hardship; for example, Germany 80 oz. a week, Denmark 85 oz., Slovakia 80 oz., Bulgaria 74 oz. In others where it is low, for example, Italy 50 oz. a week, Belgium 55 oz., Greece 30 oz., there may be danger of starvation. (All figures are those for normal consumers.) One may think that 30 oz. of bread is a fairly generous allowance, but such an amount is seriously low when there is so little else to eat. Thirty ounces of bread a week provide about 300 calories a day. The daily requirement of a normal consumer is about 2,800 calories, so that a diet which supplies only 30 oz. of bread a week may be a starvation diet if there is not plenty of other food with which to make up the calories. One way of doing this, in a diet deficient in bread, is by eating a lot of fats or potatoes; but in most countries fats are rationed and in some potatoes also. Belgium has a potato ration of 1 lb. a day, which supplies only 400 calories. Potatoes are not rationed in Greece; but this is of little value because they do not normally form a significant part of the Greek diet. The fat ration is lowest in Finland, where it is 2½ oz. a week; it is very low in Belgium and Italy (3½ oz. a week), and in France (4 oz. a week). The highest fat rations on the continent of Europe are enjoyed by Denmark with 11 oz. a week, and by Germany with 9½ oz. a week.

Meat is officially rationed in all but one country, namely, Denmark. The amount of the ration is not known for all countries, but from the figures available it appears that it is lowest in Belgium (8½ oz. a week) and France (9 oz. a week).

Sugar is rationed in all countries, the lowest being in France, Italy and parts of Hungary (4½ oz. a week).

Besides these standard foods which are rationed, many others, for example, cereal products, cheese, milk, flour, fruit, vegetables, fish, poultry, biscuits, cocoa, chocolate, jam, eggs, etc., are nationally or locally rationed.

In view of the difficulty of satisfying the calorie requirement in France the people have been urged to drink more wine, which has a calorific value of about 350 per pint. This they have done to such good effect that wine has now been rationed. The adult ration is about two litres a week. In Italy most of the population drinks, on an average, half a pint of wine a day and this provides an appreciable proportion of their calorie requirement.

The only countries in Europe to-day in which there is no food rationing are Portugal and Turkey.

Assuming that the average calorie requirement for a non-combatant or normal consumer (that is one not doing heavy manual work) is about 2,800 a day, we can, by examination of the average calorie intake in the various countries of Europe obtain a more accurate estimate of the gravity of the food situation. In the first place, Germany and Denmark have suffered very little so far. The average figure for daily calorie intake in the former is 2,900 and in the latter 3,100. In some of the other countries, however, the figures are not so good. They are the "Protectorate" (Bohemia and Moravia) 2,300, Italy 2,400, Norway 2,500, Occupied France 2,100, Unoccupied France 2,160, Netherlands 2,250, Belgium and Luxemburg 1,870. It is impossible to estimate the calorie intake in Poland and Greece because of the difficulty of obtaining figures for food consumption; but it is almost certain that they are at least as badly off as Belgium. In fact, it seems certain that Greece has been near famine for some months and that the food situation there is now extremely grave. In Poland there is no uniform system of rationing. Germans appear to be unrationed and the Poles receive a better ration than Jews. These figures indicate that many of the peoples of Europe are undergoing slow starvation. It is probable, too, that the figures given represent a rather optimistic estimate of the calorie consumption in Europe.

Deficiency occurs not only in quantity of food but also in quality. There is a serious decrease in the amount of protein eaten, and if this continues, as it is likely to do, it will have a serious effect on the general health of the people of Europe, particularly that of growing children.

There is little doubt that there is a deficiency of certain vitamins. Some months ago Dr. Russell M. Wilder, chairman of the American National Nutrition Council, stated that Germany was starving the peoples of the occupied countries of foods containing vitamin B_1 with the object of lowering their morale. (Adequate vitamin B_1 is claimed to be necessary for the maintenance of morale.) In actual fact it appears that supplies of wheat are so low in Europe that it has been found necessary to extract the grain as far as possible to make the best use of it. Thus most of the wheaten bread eaten in Europe to-day is at least 85 per cent extraction, and is therefore bread comparable with our own National wheatmeal loaf which is relatively rich in vitamin B_1 and most of the other members of the vitamin B complex. We can, therefore, safely assume that of all the vitamins, those of the B group which are found in whole cereals are least likely to be deficient in post-war Europe.

The decrease in the consumption of milk, cheese and butter will result, however, in a reduction of intake of vitamins A and D and of riboflavin. The widespread deficiency of vitamin D may have serious effects, particularly in adolescents who get no priority in food, and who, of all groups in the population, need more of everything. The increase in the use of whole-grain products combined with a restriction of milk will probably cause a widespread calcium deficiency.

In Great Britain an investigation of a series of middle-class diets by E. M. Widdowson and B. K. Alington[1] has shown that the restriction of fruit in the diet has not been compensated for by an increase in the amount of vegetables eaten, and that, therefore, the vitamin C intake has been reduced to half that consumed by the same families in 1935. It is very likely that in Europe there has been a similar decrease in the vitamin C intake of the population, and it is fairly certain that the intake of vitamin C will continue to decrease; but that in most countries it will not reach a level in which there will be serious danger of frank scurvy unless there is a widescale failure of the potato crop. The same principle will apply to Great Britain unless the consumption of vegetables is increased by inspired propaganda. The populations of some countries, such as Norway, Greece and Poland, are probably suffering now from at least a mild form of scurvy and there is every likelihood that this will become worse. Last winter in Norway, even the German army of occupation began to develop scorbutic symptoms, and at the onset of this winter, according to reports, vitamin C tablets were taken to the German army on the Russian front by aeroplane.

It is probable that at the end of this War the following dietary deficiencies will occur to a greater or lesser degree on the continent of Europe.

(1) Absolute lack of food. There will not be enough food to supply the calorie requirements of the populations.

(2) Deficiency of protein, particularly first-class protein.

(3) Deficiency of vitamin D.

(4) Deficiency of vitamin A.

(5) Deficiency of vitamin C.

(6) Deficiency of riboflavin.

(7) Deficiency of calcium.

The difficulty of securing an adequate diet particularly for the 'susceptible classes' (children and pregnant women) is appreciated by the authorities in all European countries. There is a fear in Occupied France of deficiencies, in particular of vitamins A and C, and it is proposed to produce vitamin concentrates from tunny fish liver, carrots, brewer's yeast and lemons to correct these and other possible deficiencies. Children between the ages of six and fifteen are to receive a free distribution of tablets containing vitamins A, C and D. Expectant mothers and children are to receive a portion of a distribution of 160 million vitamin pills which are to cost thirty-five million francs. All European countries are attempting by distributing vitamin pills, or by giving priority in vital foods, to keep their expectant mothers and children in good health. In Luxemburg children get free vitamin A and D capsules. In many Belgian schools the children have been eating a raw carrot every morning, and it is now proposed to distribute to them free milk, chocolate and cod-liver oil. An illuminating sidelight on the Belgian food situation is given by an advertisement which was published last year in a Ghent newspaper, which offered free supplies of vitamins A, C and D to all young men who joined up with a voluntary labour organization. In Germany in the springs of 1940 and 1941 vitamin C tablets were issued to school-children, nursing mothers, infants, soldiers and miners. Heavy workers were included in 1941. In some parts of Germany milk for infants is irradiated to increase its vitamin D content, and from three months onwards babies can receive a vitamin D preparation from the clinics. There seems to have been a possibility of vitamin A deficiency in the German diet, but it was not until January of 1941 that this vitamin was added to margarine.

Having indicated briefly the possible deficiencies which may arise it is now necessary to consider what foods will be required to remedy them. Two foods spring immediately to mind. First, wheat, and secondly, dried milk. Flour of high extraction will supply calories (1,600 per pound, 1,100 per pound when made into bread) and vitamins of the B group. The dried milk may be skimmed or whole. Whole dried milk does not keep as well as the skimmed variety and it would probably be better if the milk were skimmed, and the fat so obtained turned into dehydrated butter which will keep for a much longer time than dried whole milk. The dried skimmed milk will be an excellent source of first-class protein, of sugar, of riboflavin and of calcium. From the dehydrated butter we shall obtain fat (providing 4,200 calories per pound) and the fat-soluble vitamins A and D.

The amount of drying plant and the storage area available are the factors which will limit the amount of dried milk and dehydrated butter which will be available. It will, therefore, be necessary to store extra fats such as whale oil, concentrates of vitamins A and D, and further supplies of protein in the form of dried meat and fish. Some soya bean flour could also be stored with the object of adding it to wheat flour to give an augmented protein and calorie value to bread.

If there is widespread failure of the potato crops in Great Britain and Europe we may be faced with the problem of supplying vitamin C to a large number of people. The plant available for synthesizing vitamin C in Great Britain may be insufficient to supply our own people in such circumstances. The total requirement for vitamin C from all sources for the population of Britain is about thirty tons a year, although it is doubtful if even half this amount is actually consumed. A smaller amount still would be required just to protect the population from frank scurvy. Most of this could probably be obtained from natural sources even if there were no potatoes available, provided equitable distribution of these foods could be obtained. We should be able, however, to offer little help to Europe if there were any serious widespread deficiency of vitamin C there, unless we increased considerably our plant for synthesizing this vitamin. Fortunately, the chances of a pan-European potato failure are not very large, although there may be extensive local shortages. The situation might be met in part by the storage of orange, lemon and grape-fruit concentrates.

In conclusion, we may say that the immediate dietary deficiencies liable to be encountered in post-war Europe can be met if appropriate quantities of wheat, dried skimmed milk, dehydrated butter, whale oil, soya beans, dried meat and fish, vitamin A and D concentrates, synthetic vitamin C and/or citrus fruit concentrates are stored.

It has obviously not been possible in an article of this length to discuss all the ramifications of such a proposal, but at least it has been possible to formulate the problem and to indicate the solution.

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[1] Widdowson, E. M., and Alington, B. K., *Lancet*, 241, 361 (1941).

POTABLE WATER FROM SEA-WATER

By DR. A. PARKER

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THE possibilities of obtaining potable water from sea-water by some simple method suitable for use on lifeboats and in similar circumstances have been much discussed during the last few months in the daily Press and in other quarters. Some of the statements made and the opinions expressed have indicated lack of knowledge of the scientific and practical aspects of the problem and of the possibilities and impossibilities. In some instances the statements seem to be of obscure origin and to be reminiscent of the wonderful claims of alchemists of former times. There have been references to a mysterious method of obtaining half a glass of drinking water by adding tablets of undisclosed composition to sea-water. In the circumstances, it seems to be desirable to direct attention to some of the possible methods of removing salt from sea-water to produce potable water, and to indicate their limitations.

Composition of Sea-Water

To understand the problem it is necessary in the first place to know the concentration and nature of the salts in sea-water. Analyses of numerous samples have shown that the composition of the mixture of dissolved salts in the waters of the open sea is practically the same in all parts of the world. Though the composition of sea salt varies little from one sea to another so far as the principal constituents are concerned, there is an appreciable variation in the concentration, apart from the effects of local dilution by inflowing rivers or by melting ice. In general, however, the concentration of the salts in the open sea lies between 32 and 38 parts by weight in 1,000 parts of sea-water, and for the purpose of this article a salinity of 35 parts per 1,000 parts can be taken as an approximate average. An artificial sea-water can be made up by dissolving the following salts in distilled water containing some carbon dioxide and then diluting the solution to give a total volume of 1 litre : sodium chloride, 27·2 gm. ; magnesium chloride, 3·8 gm. ; magnesium sulphate, 1·6 gm. ; calcium sulphate, 1·3 gm. ; potassium sulphate, 0·9 gm. ; calcium carbonate, 0·1 gm. ; magnesium bromide, 0·1 gm. The weights given all refer to anhydrous salts. True sea-water also contains very small quantities of phosphates, silicates, and compounds of nitrogen, and traces of compounds of other elements. The main points, however, are that the concentration of the salts in sea-water is about 35 parts per 1,000 parts, and that nearly 80 per cent of the salt is sodium chloride.

In most of the hard waters used as sources of public water supply in Great Britain, the concentration of the salts in solution is not more than about one hundredth of the concentration of the salts in sea-water ; the salts in hard water are mainly the bicarbonates and sulphates of calcium and magnesium which are easily removed by chemical precipitation, whereas sodium chloride cannot readily be removed completely by simple chemical precipitation. It is thus clear that the problem of removal of salt from sea-water is much more difficult than that of softening ordinary hard water. At the same time, it should be mentioned that it is not necessary to remove the whole of the salt from sea-water to produce potable water. Most people would consider that water containing not more than 0·8 part by weight of sodium chloride in 1,000 parts is not too unpleasant for drinking ; but to reduce the salinity of sea-water to this value means removing more than 97 per cent of the salt. In some circumstances it may be satisfactory to drink water containing as much as say 4 parts of salt in 1,000 parts, but to reduce the salinity of sea-water only to this value would require the removal of nearly 90 per cent of the salt.

Treatment

Distillation. An obvious method of obtaining drinking water from sea-water and one which has long been used in certain parts of the world for considerable quantities of water is to boil the sea-water and to cool and condense the steam evolved. With evaporators or stills able to produce 5–20 tons of distilled water a day from sea-water, and of simple design and without elaborate equipment to conserve heat, there is no difficulty in obtaining 6–7 tons of distilled water for each ton of coal or oil burnt. If the equipment is designed and operated greatly to reduce the losses of heat by radiation and convection from the evaporator and condenser, and to recover heat from the steam, 9–10 tons of distilled water and even more can be obtained for each ton of fuel consumed. To obtain this greater efficiency requires more elaborate and costly equipment and more skilled supervision.

The question at once arises as to whether it is practicable to design a small still, which can easily be operated and will utilize the fuel with reasonable efficiency to produce say 1 pint of distilled water an hour. If the still is of simple design so that it is unlikely to fail under difficult conditions, it is improbable that the high efficiencies of some large installations can be obtained. With careful attention to the design of the still and the burner, it may be practicable in some circumstances to obtain five or six volumes of distilled water from sea-water with the combustion of one volume of oil or spirit; this represents an efficiency of heating and evaporation of the order of only 50 per cent. The space occupied by the equipment and fuel, and the weight in relation to the quantity of distilled water produced, are important factors. Investigations are in progress on the possibilities of designing a still and burner suitable for use in lifeboats. It must be emphasized, however, that the conditions to be met are stringent and the difficulties to be overcome are great. There must be no appreciable risk of failure in any part of the still or the burner.

Absorption of Water Vapour. It is possible to obtain drinking water from sea-water by utilizing the property possessed by certain substances such as silica gel of absorbing large quantities of water vapour. If silica gel is exposed over the surface of sea-water, the gel absorbs water vapour from the moist air; this vapour is replaced in the air by the natural evaporation of the sea-water, and the process continues until the absorptive capacity of the silica gel is exhausted. If the gel has been suitably prepared it may take up water vapour equal to about one fifth of its own weight. This absorbed water can be removed by heating the gel, and the vapour so obtained can be condensed by cooling. After heating, the gel can be re-used and the process repeated. In effect, this method is similar to that of simple distillation but is less efficient and presents greater difficulties.

Freezing. It has long been known that drinkable water can be obtained by melting the ice formed on cooling sea-water. As the cooling proceeds, ice separates until the remaining liquid is saturated with the salts; the solid which afterwards forms is a mixture of ice and salt. Though the latent heat of ice is very much less than the latent heat of evaporation of water, it is unlikely with present methods of refrigeration that a simple apparatus could be devised to produce drinking water from sea-water so efficiently as by distillation.

Hydrates. Another possible method is to add to the sea-water salts which dissolve readily when the water is warm and which on cooling the solution separate as crystals containing a considerable proportion of water of crystallization. The crystals can be removed and, on heating, some of these hydrated salts lose water of crystallization as vapour which can be condensed. The remaining de-hydrated or partially de-hydrated salt can then be re-used. Substances other than salts also form hydrates. A method of this kind could not be carried out so simply and efficiently as distillation.

Osmosis and Electro-osmosis. If sea-water is placed in the middle cell of a vessel divided into three compartments by two semi-permeable membranes, and fresh water is placed in the outer compartments, salts slowly diffuse from the middle compartment into the water in the outer compartments. In this way the salinity of the sea-water is decreased.

To bring about any great reduction in the salinity, very large volumes of fresh water must be circulated through the outer compartments. The quantity of fresh water required can be reduced considerably by placing electrodes in the outer compartments and passing current between them so that positive ions such as sodium migrate to one side and negative ions such as chlorine migrate to the other side. Even with this system, which requires a large expenditure of electricity, the quantity of fresh water which must be circulated through the outer cells is much greater than the quantity of sea-water converted into drinking water. This method thus seems to be impracticable.

Chemical Precipitation. It is possible to remove practically the whole of the magnesium, calcium, chloride, sulphate, bromide and bicarbonate from sea-water by the addition of chemical reagents which react with these radicals to form insoluble compounds. For example, addition of lime water precipitates magnesium as hydroxide, and bicarbonate as calcium carbonate; and soluble salts of silver remove chloride and bromide as insoluble silver chloride and silver bromide. There is much more difficulty in removing sodium and potassium, as the simple salts of these metals are all to some extent soluble. Several complex salts of sodium, which are sparingly soluble in water, are the basis of recognized methods of quantitative analysis for sodium. The conditions of precipitation, however, have to be carefully controlled, and some of the best of the precipitating agents are toxic.

Even after precipitation of the various radicals as insoluble substances, the complete separation of the precipitates is not easy, as some of the precipitates are in a finely divided condition and are not readily removed by filtration. Any toxic substances must also be removed if the treated water is to be satisfactory for human consumption. It thus seems that it is not easy to devise a simple method of removal of salts from sea-water by chemical precipitation.

Base-exchange and Acid-exchange. It has been known for a long time that certain aluminosilicates possess base-exchange properties and can remove calcium and magnesium from water. The process has been in use for some years in the well-known household water softeners and on a much larger scale in softening water for public supply and for industrial purposes. The sodium compound of the aluminosilicates is ordinarily employed for this process of water softening. When the hard water is passed through a bed of granules of the sodium compound, the calcium and magnesium bicarbonates and sulphates in the water are replaced by the soluble sodium salts, and the sodium in the aluminosilicate is replaced by calcium and magnesium. When the whole of the replaceable sodium has entered the water and has been replaced by calcium and magnesium, the material is regenerated for further use by treatment with a solution of sodium chloride, whereby the calcium and magnesium are again replaced by sodium. Though the process softens water, it does not reduce the total quantity of salts in solution.

In 1934, during the course of experiments at the Chemical Research Laboratory, Teddington, for the Water Pollution Research Board of the Department of Scientific and Industrial Research, B. A. Adams and E. L. Holmes[1] discovered that certain synthetic resins possess base-exchange properties. These resins have the advantage over the aluminosilicates that they are insoluble in dilute solutions of acids, such as sulphuric and hydrochloric acids. It was also discovered that other resins with acid-exchange properties can be prepared. By treating saline water with a base-exchange resin, previously regenerated with a solution of sulphuric acid or hydrochloric acid, the sodium chloride in solution is replaced by hydrochloric acid. When this water is treated with an acid-exchange resin, previously regenerated with a solution of an alkali, the hydrochloric acid is removed. In this way the whole of the salts can be removed from the water.

At about the time of the discovery of the exchange resins, several investigators in different parts of the world found that base-exchange material similar in properties to the base-exchange resins can be prepared by treatment of coal with strong sulphuric acid. This material can also be used in conjunction with acid-exchange resins to remove dissolved salts from water. The acid-exchange resins are unique in that no other substances have been discovered with similar acid-exchange properties.

Base-exchange materials and acid-exchange resins are now in use in several parts of the world for the removal of salts from certain waters, not nearly so saline as sea-water, to produce the equivalent of distilled water, and for the recovery of valuable materials from trade waste waters.

In sea-water the concentration of the salts in solution is so great that the volume of the exchange materials required to remove the salts is about the same as the volume of potable water obtained. It may be, however, that investigation will lead to some improvement, though the prospect of considerable improvement within a short time is not great.

It is also possible that further investigation will lead to some practicable method in which the salts are removed partly by exchange materials and partly by chemical precipitating agents. The difficulty is to develop a method which is simple in operation.

Conclusion

It may be that investigations now being made will lead to some practicable method, suitable for use in lifeboats, of obtaining drinking-water from sea-water by simple distillation or by the use of base-exchange and acid-exchange materials and chemical precipitating agents. Any method proposed, however, must be submitted to stringent tests before it is recommended, if undue risk of failure with serious consequences is to be avoided.

Meanwhile arrangements have been made to provide lifeboats with larger quantities of drinking-water than has previously been the practice.

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[1] *J. Soc. Chem. Ind.*, **54**, 1T (1935); British Patents Nos. 450,308, 450,309, and 474,361, and foreign equivalents; Annual Reports of the Water Pollution Research Board for the years ended 30th June, 1935, 1936, 1937, and 1938 (H.M. Stationery Office).

THE ANTHROPOLOGICAL APPROACH TO THE STUDY OF MUSIC

By F. H. ANGOLD

In attempting any study of this kind, or seeking to gain some light on the question of the relationship between anthropology and music, it is necessary to define the term music. The dictionary does this in the following terms: "Melody or harmony; any succession of sound so modulated as to please the ear; the science of harmonic sounds, or the art of producing such; rhythmic order."

With this definition in mind we have to realize that the definition was an attempt to explain something already in existence: musical performance preceded the definition of meaning. Music is therefore an attribute of man, apparently as old as man himself. In style to-day it varies as widely as do the characters of the human species. It is not confined to any one particular aspect of man's existence: he gives vent to music on occasions clouded by sorrow, equally as on others which are brightened by seasons of joy. We are led therefore to ask: Why on all occasions does man turn to music as the medium for the expression of feelings which words might prove inadequate to define? The animal is able to give vent to sound, the bird to trill its notes of music; man alone possesses the power to define the gifts with which he is endowed. The music used by man to express his joy or sorrow does not necessarily come exclusively from man himself; he co-operates with Nature. This reminds us of Beethoven who, visiting in after years the place where he composed his fifth and sixth symphonies, remarked to his friend Schindler: "Here I composed the 'Scene by the Brook' and the yellowhammers up there, the quails, nightingales and cuckoos round about, composed with me"[1].

To-day, music like painting is a specialized art: in earlier times it was the gift of all men. There is evidence that Palæolithic man had his music and at least possessed a primitive type of flute made with reindeer horn, while relics of the Bronze Age reveal prehistoric horns made of metal[2].

In modern civilized society the musician, like the painter, performs a particular task; he fulfils the normal functions of man, functions which so far as the majority are concerned have become atrophied through non-use. This development in the history of man has had a diverse effect upon his well-being. It means that while the vast majority may be unable to express their feelings in musical terms, the person devoting himself entirely to musical composition has been able to create a type of music far removed from the crude melodies of more primitive people. This, however, is not the whole story, for we find that the Sumerians and the Egyptians had developed a high standard of musical instruments. A good idea of the type of instruments in use may be gained from the works of Canon F. W. Galpin, Sir Leonard Woolley and C. Engel. We are faced therefore with a musical knowledge of great antiquity[3].

The question arises as to whether harmony was a feature of this ancient music, for in China there is melody but not harmony. We find that the Greeks used a crude accompaniment of drone bass to some of their songs, while Pythagoras about 600 B.C. introduced intervals. The five-toned pentatonic scale is the most primitive form now in use among civilized people. This was the form chiefly used by the Chinese even four thousand years ago, and is used in such familiar hymns as "There is a Happy Land," and Scottish songs such as "Ye Banks and Braes"[4]. That this pentatonic scale is of great antiquity in Asia there can be little doubt ; it is also interesting to find that the scale in music of Scottish and other Celtic races bears resemblance to the pentatonic scale of the ancient North American Indians[5].

In his book "Science and Music" Sir James Jeans suggests a possible manner by which organs originally designed for registering pressure in water became adapted for registering the pressure of the air, thus becoming associated with sounds and the presence of food and danger[6]. He suggests that as the result of a period of drought the fishes came on dry land (according to the geologists about 300 million years ago), the survivors eventually becoming pure land animals, and incidentally our ancestors. The new functional operation was a gradual development from the old. The illustrations in Jeans's book which are a photographic record of eddies caused by sound and water are full of interest. One shows an eddy formed at the lip of a flute organ pipe, another depicts the eddies formed by drawing an obstacle through still water, while yet another shows the type of eddy formed in water as it streams past a long thin wire. Looking at these photographs I was at once reminded of some of the Chinese landscape paintings 山水 where the water eddies are frequently depicted in a manner almost identical with the illustrations given by Jeans. Such eddies may be seen in the painting "Ten Thousand Li down the River", by Hsia Kuei, a reproduction of which is to be seen in "Chinese Art", by Ashton and Gray[7]. Incidentally, these eddies closely resemble the 'running spiral', a design which figures prominently in ornamental decoration all over the world. It seems probable that science is revealing to the present age things which in remote times were familiar but have long been obscured to the more sophisticated. If, as Jeans suggests, we are the descendants of water creatures which became pure land animals, involving a change in the functional use of our organs, we may have an explanation for the similarity in sound and water eddies. Maybe the Chinese with their greater measure of placidity have been able to keep in mind what we have lost.

The Chinese writer, Lin Yutang, describes music in the following terms : "Music is pure sentiment itself, dispensing entirely with the language of words with which alone the intellect can operate. Music can portray for us the sounds of cowbells and fish-markets and the battlefield ; it can portray for us even the delicacy of flowers, the undulating motion of the waves, or the sweet serenity of the moonlight ; but the moment it steps outside the limit of the senses and tries to portray for us a philosophic idea, it must be considered decadent and the product of a decadent world."[8]

The question of sound is full of interest. Drums and rattles seem to have been the earliest types of musical instruments ; they still figure prominently in the world of music. The hour-glass-shaped drum of China was in use in the Indus Valley early in the third millennium B.C.[9]. It has been suggested that the drum came into being as a means for reproducing the sounds made by the footsteps of walking man[10]. We are all familiar with the use of the drum for military purposes, and the part it plays in keeping men in step on the march.

Music is therefore based on hearing, the modern composer is an individual who possesses the ability of hearing sounds which to the less sensitive ears are non-existent, and of being able to put those sounds on record. Man must have music ; the closer man lives to Nature the more musical his life becomes. In music man unites with the other members of creation and, dispensing with words, using a medium common to all creatures, gives vent to sound and in so doing seeks to harmonize with Nature. He becomes a part of that undying flame, of which all through the ages man has been aware but never able to explain—life. We find therefore that modern man is not far removed from his more primitive ancestors. We may listen to some of the crude music of the African, or the weird chants of the Indian ; they are expressive. Then we may turn our thoughts to tunes such as "All through the Night", the Welsh tune without words, but one which admirably expresses the night coming over the mountains. As we listen the scene comes up before us. Or take another example, the Irish tune "Londonderry Air", to which there are no proper words. It conjures up a picture of Ireland, soul-stirring to the depths. To-day we are divided into groups. Not only is the composer in a class apart, but the ordinary people are also divided into sections : on one hand, those who are able to appreciate and enjoy music, and on the other, those who are less fortunate. Even these sections are subdivided, for among the music lovers we have those whose interest lies mainly in classical music, while others find complete satisfaction in jazz. In seeking to understand such diversity we are confronted with the fact that it is not always the educated class who appreciate good music, thus introducing the vexatious question of the difference between culture and education. We are also made aware of another fact.

Music, being creative, is therefore of necessity peaceful ; warlike music in consequence is anomalous. Music, like painting, transcends the barriers of nationality and race ; in consequence it serves as signposts to the path of man's ultimate salvation. The fact that under modern conditions it is the particular interest of the few may help to throw some light upon the tragedy of modern times, and any increasing interest shown by the majority must serve to indicate that man is slowly coming to realize what he has lost. A greater interest can only tend to reveal the truth that man's interests are common the world over, and any attempt to study the relationship of man to music must help to lead men back to the fundamental truth that there is but one race—the race of men.

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[1] Thayer, "Life of Beethoven", vol. 2, p. 120 ; Spencer and Huxley suggested imitativeness of Nature (bird-songs, etc.) as a possible commencement of emotional music ("Encyclopedia Americana", **19**, 624 ; 1937).

[2] "Encyclopedia Americana", **19**, 624 (1937).

[3] Galpin, F. W., "The Music of the Sumerians" ; Woolley, L., "The Sumerians" ; Engel, C., "The Music of Most Ancient Nations".

[4] "Encyclopedia Americana", **19**, 624 (1937).

[5] Engel, C., "The Music of Most Ancient Nations".

[6] Sir James Jeans, "Science and Music", p. 3.

[7] p. 204.

[8] "The Importance of Living", p. 145.

[9] Galpin, F. W., "The Music of the Sumerians", p. 70.

[10] Engel, C., "Music of Most Ancient Nations", p. 10.

OBITUARIES

Prof. James Wilson

The first professor to be appointed to the chair of agriculture in the Royal College of Science for Ireland by the Department of Agriculture and Technical Instruction for Ireland was James Wilson, a Scotsman who, as a student and a young agriculturist, had already won distinction in his native country, and whose death occurred on December 9, 1941. It is now forty years since he delivered his first set of lectures to Irish students, who for a period of twenty years received from him successive courses in technical agriculture and to whom the memory of Wilson will ever remain dear.

He very quickly gained knowledge of Irish conditions and made a special study of the economics of agriculture in the country. Numerous papers on this subject appeared in the *Journal* of the Department of Agriculture and elsewhere. As a result, Wilson's influence soon extended beyond the sphere of the lecture room and in a short time he became a leading figure in the field of Irish agriculture. Naturally, a man of his talent found himself in conflict with certain aspects of agricultural practice, and, consequently, much of his writing was of a controversial nature. He thought independently and wrote forcibly, but his pleasing style and frank exposition won the admiration of his readers, while his erudition commanded the respect even of those with whom he disagreed.

Wilson's greatest contribution was, however, in the sphere of scientific agriculture. He was an ardent student and an untiring worker, and his many publications on the breeding and feeding of farm stock testify to his industry and ability. Most of his scientific work is recorded in the *Scientific Proceedings of the Royal Dublin Society*, in the activities of which he took the keenest interest. He specialized in Mendelian heredity. Among his productions on this and cognate subjects are the following books: "A Manual of Mendelism", "The Principles of Stock Breeding", "The Evolution of British Cattle". Later his attention was directed to stock feeding, on which subject numerous contributions flowed from his pen. The comprehensive volume, "The Principles of Stock Feeding", was his latest big work in this connexion.

As a lecturer and teacher Wilson endeared himself to his students. His geniality was overflowing and his method of imparting knowledge quite fascinating. Formal lectures he disliked: he preferred to converse with his class and a feature of his lecture was that the students talked as much as the professor. His students are now engaged in a variety of agricultural activities where the influence of the teacher will be manifest for many a year.

J. P. Drew.

Mr. Geoffrey Milne

The death, at Nairobi on January 16, of Mr. Geoffrey Milne, of the East African Research Station, Amani, at the age of forty-three, deprives the world of a most able and experienced investigator of tropical soils. Mr. Milne, who was the brother of Prof. E. A. Milne, Rouse Ball professor of mathematics in the University of Oxford, graduated at the University of Leeds in 1921, to which he returned after a period as agricultural chemist in the University of Aberdeen, to occupy a post in the Department of Agriculture. He joined the staff at Amani in 1928 and quickly earned a reputation in the field of soil geography. It is largely due to his efforts that soil cartography has been unified throughout the East African dependencies and a rational basis established for soil classification. He combined in an unusual degree the qualifications of a geographer and a laboratory worker, and of a theoretical and a practical soil scientist.

Mr. Milne will be remembered chiefly as the editor and principal compiler of the first soil map of East Africa, published in 1936. The map, though necessarily incomplete, introduced many novel features of soil cartography. In particular Milne made use for the first time of the concept of the 'catena', a sequence of several soil types recurring in regular order in association with certain types of topography, usually undulating or hummocky. This marked the formal recognition by soil cartographers that the delineation of type of landscape may be equally important on a soil map as type of soil.

In recent years Milne was much occupied by the urgent practical problems of soil conservation in East Africa, and in 1938 made an extensive tour of the American soil-conservation stations. Afterwards he published a report of his tour that gave an exceptionally vivid picture of the state and organization of soil research work in the United States. At the time of his death, he was about to take up the post of scientific secretary to the East African Supplies Board.

Prof. F. von Müller

Prof. Friedrich von Müller, emeritus professor of internal medicine at Munich, a brief announcement of whose death appeared in the *Schweizerische medizinische Wochenschrift* of November 29, was born on September 17, 1858, the son of the director of the Augsburg Hospital. After studying medicine at Würzburg and Munich, where he qualified in 1882, he became assistant to Prof. Carl Gerhardt, whom he accompanied to Berlin in 1885. He was afterwards appointed professor of medicine at Marburg, Basle and finally at Munich, where he became director of the Second Medical Clinic.

According to Garrison, who describes him as "perhaps the most scientific teacher of internal medicine to-day", he had one of the most largely attended clinics in Europe. He was well known in Great Britain, where he was elected an honorary member of the Clinical Section of the Royal Society of Medicine in 1933. His first publications were devoted to problems of physiological chemistry, such as the metabolism of albumin, fat absorption, the origin of urobilin, and metabolism in fever and convalescence. Later he directed his attention to various departments of internal medicine, including intestinal intoxication, exophthalmic goitre, Bright's disease and bronchitis. His principal books were a handbook of clinical diagnosis in collaboration with O. Seifert (1886), investigations on two fasting men (1893) and some problems in metabolism and nutrition (1900).

J. D. Rolleston.

We regret to announce the following deaths:

Prof. T. Levi-Civita, For. Mem. R.S., formerly professor of mechanics in the University of Rome, on December 29, aged sixty-eight.

Prof. Virgilio Tedeschi, professor of biological physics in the National University of La Plata.

NEWS and VIEWS

Royal Meteorological Society: New President

The election of Prof. D. Brunt as president of the Royal Meteorological Society will be welcomed by all meteorologists. Prof Brunt received a mathematical training at Cambridge and lectured on mathematics before joining the Meteorological Section of the Royal Engineers in 1916. During the War of 1914–18 his first book appeared, on "The Combination of Observations", which gave a systematic account of the application of mathematics to observational data, especially in meteorology; it reached a second edition in 1931. After the war ended, he joined the staff of the Meteorological Office as superintendent of Army Meteorological Services, where he remained until 1934. During this period he carried out a great deal of research into periodicity in meteorological phenomena, bringing to the subject rigid mathematical criteria of reality which did a great deal to correct the rather credulous attitude of earlier workers, and disposed of the belief in dominant 'weather cycles'. He then turned his attention to dynamical meteorology and to the fundamental physical properties of the atmosphere, especially in connexion with radiation. In 1934 he was appointed to the chair of meteorology at the Imperial College of Science and Technology, succeeding Sir Gilbert Walker. In the same year he published his well-known text-book on "Physical and Dynamical Meteorology", from which most of the younger generation of meteorologists have received a thorough grounding. He was elected to the fellowship of the Royal Society in 1939. Prof. Brunt has been associated with the Royal Meteorological Society for many years, as councillor, vice-president, editor and as the author of numerous stimulating papers in the Society's *Quarterly Journal*.

Conference on European Agriculture

The British Association announces a conference on "European Agriculture: Scientific Problems in Post-War Reconstruction", arranged under the auspices of the Division for the Social and International Relations of Science as a matter arising out of the recent conference on Science and World Order. This agricultural conference will be held on Friday and Saturday, March 13 and 14, in the rooms of the Royal Society, Burlington House, London, W.1. There will be morning and afternoon sessions on each day, and British and foreign experts will deal with such subjects as the immediate technical steps necessary for reconstruction, settlement, marketing and prices, farm and factory, nutrition, the co-operative system, land reforms, peasant prosperity, excess population, peasant education, the improvement of peasant farming, livestock problems, artificial insemination, milk production, market gardening, and the relations of European agriculture to world conditions. A regional survey of European agriculture is contemplated, inasmuch as it is felt that many of the problems of reconstruction may be better viewed regionally than within the limits of political divisions. The chair of the opening and closing sessions will be taken by Sir John Russell; the names of other chairmen and of speakers will be announced when the programme is complete. Further particulars can be obtained from the Secretary, British Association, Burlington House, London, W.1.

Science and World Order

A bulletin has been issued by the British Association summarizing action taken and inquiries made by the officers and council of the Association and the executive of the Division for the Social and International Relations of Science, down to the end of January, on matters arising out of the Conference on Science and World Order. *The Advancement of Science*, No. 5 (Pp. 120, 5*s*.), contains a full report of the transactions of the Conference, together with certain related communications received later. A Penguin volume on "Science and World Order", based on the proceedings of the Conference and compiled by J. G. Crowther, D. P. Riley, and Dr. O. J. R. Howarth, is in preparation. On the direction of the Council of the Association, the executive subcommittee of the Division convened a meeting, which included representatives of Government and other bodies interested in building and territorial planning to consider what action, if any, might be desirable on the part of the Association in connexion with this matter. It was decided to form a representative committee, in accordance with a regular practice of the Association, to inquire into and report upon the state of science in relation to building and territorial planning, with the view of summarizing the present position of researches in these connexions and indicating their services.

The executive subcommittee of the Division, on the instruction of the Council, held a meeting, with assessors, to consider what action, if any, should be taken by the Association in relation to post-war university education. It was decided that a committee be appointed with wide terms of reference, as follows: (*a*) To consider the general policy and methods of university education with a view to promoting international collaboration and the free interchange of ideas, and relating university education to the needs and service of the community; (*b*) to consider the replanning of teaching departments and curricula in accordance with modern conceptions of the inter-relations of different branches of knowledge, particularly those of science and the humanities; (*c*) to survey the position regarding teaching material, apparatus, books and staff in universities which have been damaged, destroyed, disorganized, or closed as a result of the War, and to make recommendations for their rehabilitation. This committee is in progress of formation; its joint secretaries are Prof. F. E. Weiss and Mr. A. Gray Jones.

Certain further matters have appeared, after inquiry, not to call for action, or at any rate immediate action, on the part of the Association. Thus, the Council has taken no immediate action upon various suggestions, made during and after the Conference, concerning the establishment of an international league of science, and a standing consultative committee representative of British and foreign science in Great Britain. The Council endorsed the view of the executive subcommittee of the Division that the International Council of Scientific Unions and the Unions themselves, if effectively reconstituted after the War, should provide adequate opportunities for international co-operation in science; and it is understood that discussions to this end are in progress. The Association received a report arising out of proposals for a register of, and meeting-place for, foreign men of science now in Great Britain. It is understood that material exists for a register in the records of the International Labour Department of the Ministry of Labour and of other organizations; also that another organization is contemplating the provision of facilities which may offer arrangements for periodical meetings of allied scientific workers.

Carrots for Domestic Animals

WAR conditions have established the merits of carrots as an ingredient of the human dietary: that they are no less excellent as a food for farm animals, is shown in a recent article by Mr. H. E. Woodman, of the School of Agriculture, Cambridge (*J. Min. Agric.*, 48, No. 3, 185; 1941). Indeed, all kinds of stock are fond of carrots, and although their importance in animal feeding is overshadowed by that of the other root crops—swedes, mangolds and turnips—this is not due to any inferiority in feeding quality, but rather to price considerations and to the fact that when the human requirements in Great Britain have been met, the supply of carrots left over for animals has usually been quite small. This year it seems there will be a large surplus. On the basis of starch equivalents, 80 lb. of carrots should be able, on an average, to replace 100 lb. of mangolds, or 90 lb. of swedes. With the more watery turnips, however, two parts by weight may be replaced by one part of carrots. Carrots are not so rich as swedes in vitamin C, the anti-scurvy factor, but are distinguished from all other roots by their high content of carotene. Since this yellow pigment is convertible into vitamin A in the body of the animal, it follows that carrots are a good source of this important health factor.

Raw carrots have always been a favourite food for horses. The allowance should not exceed 20 lb. per head per day, but smaller amounts may be fed with benefit to condition. They should be used in partial replacement of oats, 7 lb. of carrots being equal to 1 lb. of the cereal. Dairy cows may receive up to 40 lb. of sliced carrots per head per day and fattening bullocks up to 60 lb. The carotene in the carrots enriches the colour of winter milk and improves its content of vitamin A, and for this reason, carrots are specially valuable when the dairy ration contains neither kale nor silage. They may be used to replace dried sugar-beet pulp (7 lb. of carrots = 1 lb. of dried beet pulp) or cereals (8 lb. of carrots = 1 lb. of crushed barley). Pigs may also be given carrots with advantage to health and condition; and cereal meal, up to one fifth of the total ration, may be replaced by this succulent food, of which 8 lb. should be fed for every lb. of cereal meal replaced. The carrots form a useful source of vitamin A for pigs that are kept entirely indoors. Some authorities recommend cooking or steaming them for pigs, but the full beneficial effect is only obtained when they are fed raw. Grated or shredded carrots, when mixed with the meal ration, provide a palatable and health-promoting feed. Carrots form a useful supplement to the growing and laying mashes of poultry during winter, and their vitamin A potency is particularly beneficial in these cases. They are best fed raw. Grated or shredded carrots may replace cereals up to one fifth of the total mash, 8 parts by weight being used to replace 1 part of cereal.

Carnegie Corporation of New York

IN the report of the president of the Carnegie Corporation of New York, covering the year ended September 30, 1941, Mr. Frederick P. Keppel, who retired from the presidency on November 18, states that of grants totalling 2,706,834 dollars made during the year, 500,000 dollars were allocated for matters relating directly to the national emergency. Special stress is laid upon the importance of timing in enterprises involving effective co-operation between public and private agencies, public offices, and private citizens or groups. Besides contributions to the National Academy of Sciences totalling 100,000 dollars, emergency grants were made to the Institute of Public Administration for special studies undertaken at the request of Government agencies, to Harvard University for training supply officers, to the National Bureau of Economic Research and the Institute of Pacific Relations, as well as to other agencies. Of other grants, 398,511 dollars was allotted for library interests, including support of the *Journal of Documentary Reproduction*, 566,930 dollars for adult education and 906,956 dollars for research and studies. The Committee on Scientific Aids to Learning has steadily proceeded with its work in the fields selected for intensive study, namely, the problems of microphotography, including visual fatigue, and the development of the best visual and auditory equipment for classroom use. From the special fund set aside by Mr. Carnegie for the Dominions and Colonies, 70,000 dollars was allotted for library and educational services in Trinidad and the Windward and Leeward Islands, 30,000 dollars for the research activities of the International Labour Office at McGill University, 14,800 dollars to the Canadian Research Council in the Social Services and 7,500 dollars to the Royal Institute of International Affairs for a study of the internal economy and external relations of Newfoundland; a further grant has also been made to the Carnegie Endowment for International Peace.

Mr. Keppel's report includes a review of developments and changes in the field of activity of the Carnegie Corporation during his nineteen years of office, in which he emphasizes the possibility of a foundation adjusting itself to meet sharply changing conditions if its house is in order financially and otherwise. Its trustees should not only represent financial judgment and experience but also lay opinion, and they should possess a true understanding of the importance of education in a civilized society. He also stresses the value of a closely knit programme in each field of activity, and the necessity of being prepared to withdraw from a field in which the law of diminishing returns begins to operate, and finally the importance of timing, of endeavouring to have the idea, the man and the setting in perfect conjunction: the idea, vital and timely; the scholar or executive at the peak of his powers; and the organization at flood tide.

Rodent Pests in War-time

MR. A. D. MIDDLETON has given some useful information for the control of the rabbit population of Great Britain (*J. Min. Agric.*, 48, No. 2). He believes the best prospects for success depend upon better co-ordination of effort with county pest officers instead of individual efforts at control without co-operative schemes, but that it is unreasonable to commercialize it and to expect a profit from rabbit control. However, the high price of rabbits and the intensive efforts of gamekeepers and trappers appear to have reduced the rabbit to comparative scarcity over most parts of Great Britain, a position approaching that of the end of the War of 1914–18, when wild rabbits became very scarce. On the other hand, the position of the rat is still serious, and in some 'blitzed' centres and ports with bigger food stores than usual, conditions have encouraged its increase. In an article on rat control (*Lancet*, 1, No. 5, 1942), Mr. Eric Hardy directs attention to the value of asbestos and three-ply wood as rat-proofing materials when many usual materials are unobtainable. White arsenic is the most useful of the poisons permitted by the law. Attention is also directed to the need for using more traps—even ten times as many traps as rats—and to using unbaited traps, and the encouragement of those predatory enemies of rats in the countryside usually destroyed by game-preservation, namely, stoats, foxes, badgers, owls, herons, otters, buzzards and polecats. The Ministry of Food's Infestation Order 1941, which came into force in January, gives added power for compulsory control of rats and other warehouse vermin.

/ood Pigeon Investigation

THE British Trust for Ornithology is organizing a winter wood pigeon investigation in the British Isles which ought to shed much light upon the habits of this serious agricultural pest. Although organized from the natural history point of view, the investigation may well provide information of considerable value in the control of this pest. Explanatory forms and recording cards for field counts and roost positions have been circulated, and the inquiry will also include the examination of crop-contents of shot birds and post-mortems upon diseased birds. The field counts will make observation upon the sizes of the local flocks at every opportunity when they perch, feed, roost or are in flight, and in addition to recording the day and place, the hour of the count will be noted. Record will also be made of their daily feeding, drinking and resting times, and the influence, if any, of fog, mist, rain and increasing daylight, and if special fields are favoured for feeding and resting. Observations will be made to see if the flocks remain intact throughout the day or break up, and if pairing takes place in flocks. The roost observations will count or estimate the number of birds using the roosts, the type of wood, the trees most favoured, the period in use, and whether it is used annually and if the size of the roosting flock is increasing or decreasing. An effort will also be made to get experienced people to weigh, measure and determine the sex of shot wood pigeons. The field counts will be returned to the Edward Grey Institute at Oxford monthly, and the rest of the winter stage of the investigation will be completed by the end of May.

The Swedish Botanical Garden

THE January issue of the *Anglo-Swedish Review* announces that the Bergianska Trädgården or Bergianum, the botanical garden of Stockholm, is to mark its hundred and fiftieth anniversary this year. It was founded in 1791 by Peter Jonas Berg, a doctor of medicine and a botanist, who bequeathed it to the Swedish Academy of Science. It consists of a purely scientific botanical section and a practical section, which in peace-time carries on a large exchange of seeds with most of the botanical gardens abroad. Among the latter is the botanical garden of Tokyo, which had to place considerable orders to complete its collections, part of which were destroyed in the earthquake ten years ago. The Bergianum is also in close touch with the United States, and some plants from the salt steppes of Russian Turkestan recently came from Russian botanical gardens. Most of the seeds received are of purely scientific interest, but sometimes seeds and plants of commercial value are also received. The results of experiments on the effects of the vigorous cold of the last two years on different plants will shortly be published in *Acta Horti Bergiani*, which contains the results of research work in systematics, cytology and embryology. The celebrated collection known as "Iconotheca Botanica Bergiana" contains 10,000 photographs by most of the botanists in the world. A large room in the main building is filled with cupboards which originally belonged to Bergius and contain his collections of plants and insects. Thanks to a donation, the Bergianum will soon have a winter garden where all the flora of the Mediterranean will be grown.

Public Health in India

ACCORDING to the annual report for 1940 of the Public Health Commissioner with the Government of India, there were no abnormal outbreaks of disease in that year, and the common epidemic diseases such as malaria, smallpox and plague had been less prevalent than in 1939. The most important public health event was the third meeting of the Advisory Board of Health at Poona, where reports were made on the compulsory inoculation of pilgrims at festival centres against cholera and on the control of food adulteration. The Board recommended a plan for the provision of laboratories, including for each Province or State a central laboratory, regional laboratories for groups of districts and others for individual districts. The low incidence or complete absence of the common infectious diseases such as cholera, smallpox and plague in the prisons, of which the daily population was more than 13,000, showed the efficacious control of these infections. The report also contained a chapter on medical research, especially on nutrition, by the Indian Research Fund Association, field studies on cholera, plague and malaria, leprosy research carried out mainly at the Calcutta School of Tropical Medicine, and maternal mortality investigated at Calcutta, Bombay, Delhi and Madras. Cerebrospinal fever had occurred in sporadic form in many provinces.

Radio Receiver Design

IN the past few years radio manufacturers in Great Britain have awakened to the fact that the export industry has been very much neglected. This is shown clearly in a paper read before the Students and Graduates Sections of the Institution of Electrical Engineers by Mr. J. H. Lemmon, on "Tropical Receiver Design" (*Quart. J. Inst. Elec. Eng.* of December 1941). In British colonies, the majority of radio receivers in use until about 1938 were of either American or Dutch origin. British manufacturers had sent out to India or other tropical countries receivers which differed very little from those sold in the home market, and little attention was paid to the internal parts of the receiver. Mr. Lemmon takes India as the basic country, since a fairly comprehensive knowledge of the radio markets there is available. In India, where the transmitters may be many hundreds of miles apart, medium-wave broadcasts are not of very much use, except for local listening-in areas near the large towns. They cater mainly for the local inhabitants and native listeners, and the value of the programme transmitted from one town may be of very little use in an adjacent area. The European listener abroad wants to hear programmes and news from his home country, and for this reason he has to rely on short-wave listening. The most used wave-lengths for this purpose are in the 13-, 16- and 19-metre bands, which give reliable services over very long distances for the greater part of the year, while certain other stations work on 30-, 60- and 90-metre bands. The exported radio receiver therefore, in addition to withstanding tropical conditions, should cover all wave-bands from 13 metres to 90 metres, and also medium waves between 200 metres and 330 metres.

Infra-Red Radiation in Industry

A PAPER on "Infra-Red Radiation and Equipment: their Application to Industrial Processes", read recently by Mr. R. Maxted before the Illuminating Engineering Society, emphasizes that the technique of radiant heating depends on direct experiment rather than upon an understanding of wave-length effects, properties of materials, etc., although a knowledge of the spectral characteristics of the materials is necessary if optimum combinations of wave-bands and materials are desired. Transformation into sensible heat is one effect of the absorption of radiant energy, and radiant heating depends entirely upon this effect, the energy absorbed by the material being instantly converted into heat upon exposure to radiation. The incident energy is partially reflected, transmitted and absorbed when any substance is irradiated, the magnitude of each effect ranging throughout the electromagnetic spectrum with any given material. The direct effect of absorption is that energy is re-radiated at longer wave-lengths, change of structural state takes place, or sensible heat is produced within the absorbing substance.

Radiant heating is usually employed for dehydration, enamel stoving, or other change-of-state phenomena, and it is believed that the practical results obtained are solely due to heat application and not to any structural change arising from the direct action of radiation. Further developments may conceivably lead to the utilization of spectral effects but present-day practice aims at applying heat. It should be noted, however, that while interest centres in the thermal effects of absorption, the material receiving heat treatment is not necessarily the absorbing substance; an enamelled metal sheet, for example, may be irradiated from the back, or a transparent lacquer may be indirectly heated by absorption in the under surface.

Summer School in Human Biology

DURING the last year, the Educational Advisory Board of the British Social Hygiene Council has arranged, in co-operation with local education authorities in different parts of the country, refresher courses in biology for teachers. These were primarily designed to help to equip teachers with a background of biological knowledge, to undertake, in the schools, courses similar to the School Leaver's Courses proposed by the Board. In several areas teachers attending these lectures have expressed a wish for a further course of practical work, and to meet this demand, and that of other teachers, a summer school in human biology has been arranged to be held in Cambridge during August 5–19.

The school is planned to be of help to teachers in junior and senior schools and the junior forms of secondary schools. Each morning there will be a lecture on some biological topic, followed by practical laboratory work. The practical work will consist mainly of fairly simple experiments and demonstrations of such a nature as to be of use in schools where comparatively little equipment is available. In the afternoons there will be organized excursions to places of interest such as various research laboratories and biological museums and institutes. After tea each day there will be seminars at which practical teaching problems will be discussed, and there will be a display of biological films and text-books.

Most evenings after dinner will be devoted to lectures, by eminent biologists, on the social implications of biology. Accommodation will be provided in one of the colleges for both men and women. There will be free time in which the members of the school will be able to visit the colleges and other places of architectural and natural interest. Further details may be obtained from the Education Officer, British Social Hygiene Council, Tavistock House South, Tavistock Square, W.C.1.

Food and Nutritional Needs

THE Nutrition Society has arranged a whole-day conference on "Food Production and Distribution in Relation to Nutritional Needs" to be held on February 28, beginning at 10.30 a.m., at the London School of Hygiene and Tropical Medicine. Papers will be read by Sir John Orr ("The Agricultural Implications of a Food Policy Based on Nutritional Needs"), Dr. N. C. Wright ("Rival Claims of Animals and Man for Food"), Mr. E. T. Halnan ("Animals as Food Converters") and Sir John Russell ("Planning for Agricultural Production"). Among those who have agreed to participate in the discussion are Prof. A. W. Ashby, Sir Joseph Barcroft, Mr. A. N. Duckham, Prof. H. D. Kay and Dr. T. F. Macrae. Sir Wilson Jameson (chief medical officer, Ministry of Health) will take the chair at the morning session. Provisional arrangements have been made for further meetings to discuss, among other topics, (1) "The Preparation of Food in War-time with Special Reference to Collective Feeding" and (2) "Nutritional Requirements for Optimum Health". Further information about the Nutrition Society can be obtained from the Hon. Secretary, Dr. Leslie J. Harris, Dunn Nutritional Laboratory, Milton Road, Cambridge.

The Newton Tercentenary

NEWTON was born on Christmas Day, 1642. The Physical Society will celebrate the tercentenary of his birth by holding a special meeting at which an address will be delivered dealing with the life, work and influence of Newton. The lecturer will be Prof. E. N. da C. Andrade, Quain professor of physics in the University of London. Details of the meeting will be announced later.

LETTERS TO THE EDITORS

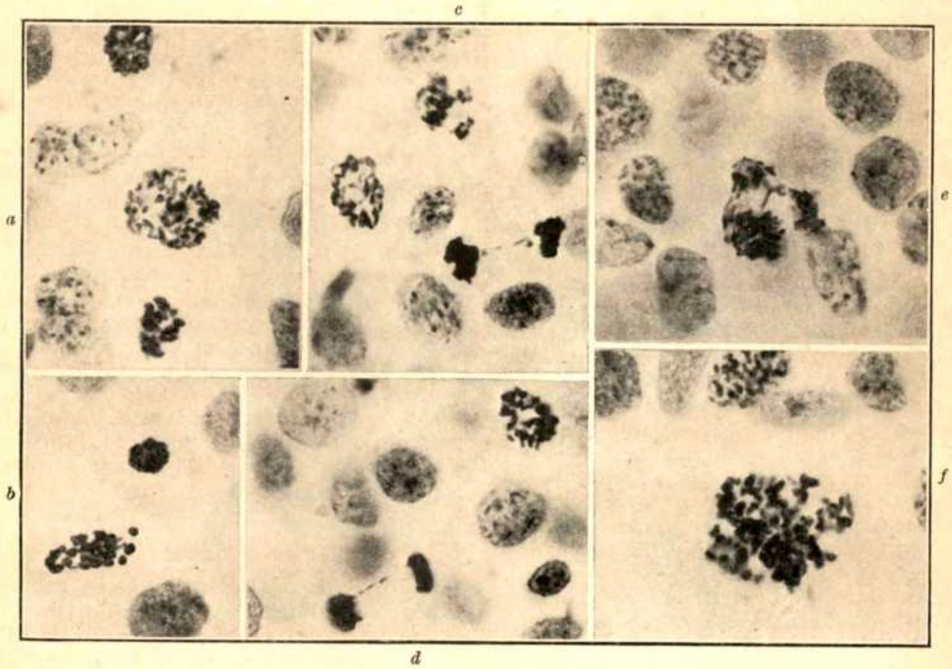
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Technique for Mitosis in Tumours

In cancer therapy it is of great interest to distinguish between tumours according to their degree of mitotic activity. This requires a determination of he proportion of dividing to resting cells. It may ven be useful to follow the character of mitosis after X-ray treatment. Human cells are difficult to andle for this purpose. The usual techniques are edious and unsatisfactory. Indeed, misleading conlusions have often been reached owing to the indequacy of the preparations used. In contrast with he older methods, I find that La Cour's aceticacmoid (resorcin-blue) treatment[1] is rapid and, as may e seen from the photographs, capable of showing oth the character as well as the stage of division.

The method is as follows. Fix small pieces of umour in acetic-alcohol (1 : 3) for 10 min.–24 hr. efore staining, cut small shreds of tissue from the urface with scalpel and transfer them into 10 per ent acetic acid for five minutes and 45 per cent for en minutes. Then stain with warm (40° C.) aceticacmoid for 15–30 minutes. Put one drop of aceticacmoid on slide with one piece of stained tissue. rush the tissue by tapping with the blunt end of a one needle-holder. Remove all unmacerated fragents. Cover and press with blotting paper to spread he cells and remove surplus stain. Heat slide gently ithout boiling. It is at once ready for study. If equired for further use, keep slide 1–5 days in moist atmosphere at freezing point and make it permanent by the usual method[1]. In order to make well-stained permanent preparations, leave tissue in aceticlacmoid for twenty-four hours. Using the above method, good smear preparations of rat carcinoma and mouse sarcoma have also been obtained.

Fixed tumour tissues can be stored in 70 per cent alcohol, but the best preparations are obtained from freshly fixed material. If the tissue is left in fixative more than forty-eight hours the chromosomes swell and their staining is not satisfactory.



Microphotographs showing various types of dividing cells in tumour of the cervix. Magnification 2,300. (Material was kindly supplied by the Radium Institute, Manchester.)

(*a*) Two diploid and one tetraploid mitotic metaphase.
(*b*) Abnormal mitotic metaphase in a haploid cell; only 24 chromosomes are present.
(*c*) Delayed separation of two daughter chromosomes at anaphase.
(*d*) Chromatid bridge at mitotic telophase.
(*e*) Tripolar spindle in a tetraploid cell.
(*f*) Highly polyploid, probably octoploid cell in division.

The work is a part of the programme aided by the British Empire Cancer Campaign.

P. C. Koller.

Institute of Animal Genetics,
University of Edinburgh.
Jan. 16.

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[1] Darlington, C. D., and La Cour, L. F., "The Handling of Chromosomes" (Allen and Unwin, London, 1942).

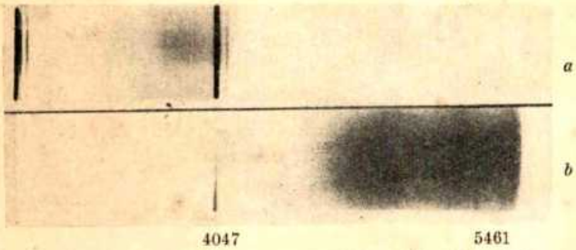
Fluorescent Lipoidal Spectra of Human Tissue

Hieger[1] pointed out that most of the carcinogenic hydrocarbons studied were highly fluorescent and they produced characteristic bands in the regions 4,000, 4,180 and 4,400 A. The investigation of the presence or absence of similar spectrographic characteristics in non-malignant and malignant tissues was instituted with the end in view that it might shed some light on the presence of possible carcinogens in the latter.

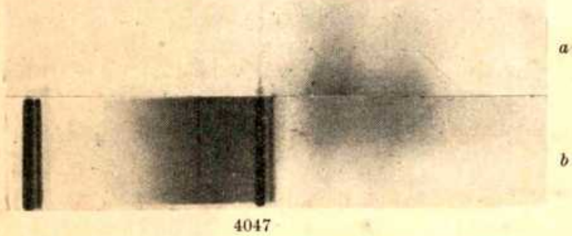
In 1935 I suggested the possibility that "cholesterol or some of its decomposition products" may, under certain conditions, act as carcinogens[2]. Among such compounds methyl cholanthrene is considered "the most active cancer-producing agent known . . . yet the actual presence of any such substances in traumatized tissues has not been demonstrated"[3]. On the basis of the hypothesis of cholesterol carcinogenesis this work dealt primarily with an acetone-soluble lipoid fraction obtained from human cancer tissue.

In connexion with the fluorescence phenomenon it was noted that the cancer tissue lipoids produced a far stronger fluorescence within a given period of time than the lipoids obtained from non-malignant tissue.

The apparatus used consisted of a spectrograph, made by combining a direct-vision spectroscope, in which the spectrum, produced by a glass prism, was photographed with an $f/2 \cdot 5$ camera, a mercury arc, and a filter eliminating light up to about 3,400 A.



FLUORESCENCE OF (*a*) NON-CANCEROUS; (*b*) CANCEROUS TISSUE, PARTIALLY DEPROTEINIZED.



FLUORESCENCE OF (*a*) METHYL CHOLANTHRENE; (*b*) CANCEROUS TISSUE, MAXIMUM DEPROTEINIZATION.

A Pyrex container specially blown to egg-shell thickness, of about 50 mm. in diameter and about 40–50 mm. in depth, was placed with the solution directly under the filter. The spectrograph was placed at right angles to, and about 10 mm. from, the container. It is noteworthy that an empty Pyrex container did not register any fluorescence above 4,047 A.

All tissues used were carcinomata. Briefly, the lipo-proteins were prepared as follows:

Tissue was minced, then ground very finely with sand and extracted alternately with acetone, petroleum ether, and acetone, 250 c.c. of solvent to 100 gm. of tissue. These extracts were pooled, evaporated and then treated with excess acetone to precipitate out the lecithins. The acetone solution was then placed in a refrigerator for forty-eight hours, filtered and evaporated. (This may have to be repeated until residue gives a clear solution in excess cold acetone.)

Other methods, whereby a greater amount of lipo-protein may be obtained from a given quantity of tissue, are being investigated. The results will be published in a subsequent communication.

About 10 c.c. of the lipo-protein was shaken vigorously with 3–4 times its volume of a saturated alcoholic solution of mercuric chloride and allowed to stand about twenty-four hours. To this was added a saturated alcoholic solution of caustic potash until pH8 or higher was reached. This was filtered. and the precipitate washed several times with petroleum ether, which was added to the filtrate. The partitioned petroleum ether fraction was then pipetted off, washed again with alcohol caustic potash solution, re-pipetted off, evaporated and the pale yellow lipoid fraction taken up in CP toluene. The resultant solution (about 0·5 per cent) must be clear.

The spectrographic differences between partial and maximum deproteinization as well as the difference between normal and malignant fractions are shown in the accompanying plates. These differences are easily recognized.

There seems to be a qualitative as well as a quantitative difference in the fluorescence between non-cancerous and cancerous tissue lipoids. Spectrographic characteristics identical with those found in methyl cholanthrene are evident in the lipoid of human cancer tissue (carcinoma).

I wish to express my sincere thanks to Prof. Joseph Kaplan and to Dr. S. M. Rubens of the University of California at Los Angeles, for their co-operation and assistance in obtaining the spectrographic data in connexion with this work.

H. S. Penn.

Department of Physics,
University of California
at Los Angeles.

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[1] Hieger, I., *Biochem. J.*, 505 (1930)..

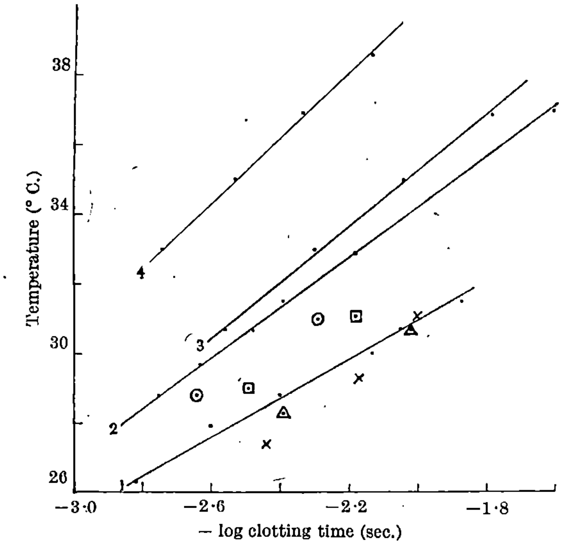
[2] Penn, H. S., *Med. Rec.* (1935).

[3] Ewing, James, "Ewing's Neoplastic Diseases", p. 106.

The Second Phase of Rennet Coagulation

Various hypotheses have been put forward in attempts to explain the clotting of milk by rennet. That from the Carlsberg Laboratories[1,2] has probably been the most widely accepted. This theory states that the clot is due to the precipitation of the insoluble calcium salt of paracasein after the enzymic alteration of a constituent of the original casein, which is presumed to behave, before this alteration, as a protective colloid for the other constituents. Thus the coagulation process can be divided into two phases, one enzymic and one non-enzymic. It has been generally agreed that these two phases can be differentiated, but their precise nature has not yet been made clear.

This note is concerned with the second phase sometimes referred to as the precipitation of calcium paracaseinate[1,3]. This is probably not the simple precipitation of an insoluble salt; for example, it does not occur readily at a low temperature. Effront states[4] that below 15° C. milk is not clotted by rennet although the enzyme does alter the protein. Most chemical changes, including the majority of enzyme reactions, have a temperature coefficient of 2–4 per 10° C. That this coefficient holds approximately for rennet over the range 37°–0° C. is shown by the fact that the first phase is completed at 0° C. after a definite time which can be calculated from that required at 37° C. For example, a sample of milk which contained sufficient rennet to clot it in eight minutes at 37° C. was kept at 0° C. for 130 minutes ($130 = 8 \times 2 \cdot 12^n$, where $n = 37/10$). Its clotting time at 37° C. was then 90 seconds. Longer storage at 0° C. caused only a slight further reduction of clotting time. This took place at the rate of seconds only per day. Thus a method is available for separating the two phases of rennet action, and the effect of various factors, such as temperature on the second stage, can be studied.



1. Raw milk, No. 1
2. Raw milk, No. 2
3. Pasteurized milk
4. Reconstituted spray-dried skim milk powder

⊙ No. 2 after 24 hr. at 0° C.
▷ No. 2 after 48 hr. at 0° C.
⊡ No. 2+N/5,000 $CaCl_2$ after 24 hr. at 0° C.
× No. 2+N/500 $CaCl_2$ after 24 hr. at 0° C.

Using samples of milk on which rennet has been allowed to complete the first stage of its action at 0° C., it has been found that the relation between temperature and rate of clotting over a range of clotting times from 1 to 9 minutes is described by the equation

$$R_{(T+t)} = R_T e^{kt},$$

where $R_{(T+t)}$ is rate of clotting at $T+t$° C. (1/clotting time in seconds), R_T is rate of clotting at T° C., and k is a constant, the value of which depends upon the milk.

Thus the graph obtained by plotting log rate against the temperature is a straight line. The observed values of k were 0·46 for fresh milk, 0·32 for another milk which had been preserved at 1° C. for a day, 0·28 for pasteurized milk, and 0·25 for reconstituted spray-dried skim milk. These values of k correspond to temperature coefficients $\left(\frac{R_T+1}{R_T} = e^k\right)$ between 1·6 and 1·3 per degree. The only relevant reaction with a temperature coefficient of this order is the denaturation of proteins. That of ovalbumin has a coefficient of 1·9 per degree between 60° and 70° C., while the corresponding figure for hæmoglobin is 1·3 over the same range[5]. It is therefore suggested that the second phase of the coagulation of milk by rennet is a denaturation (unfolding and relinking of polypeptide chains) or partial denaturation of the casein, which has been rendered heat-sensitive by the enzyme.

This hypothesis is supported by the sensitiveness of the reaction to calcium ions. Addition of calcium equivalent to N/5,000 in the milk led to a decrease in clotting time of 18 per cent, and an increase to N/500 caused a decrease of 61 per cent in the clotting time. The temperature coefficient of the reaction was not affected by the presence of added calcium.

A phosphorus-containing protein from malt wort also exhibits this phenomenon[6]. In the absence of calcium, it can be heated under certain conditions for several hours at 100° C. without coagulating, but in the presence of N/200 calcium chloride it coagulates as soon as the temperature reaches 50° C.

Most of the lines in the accompanying graph converge as the temperature diminishes and would meet between 10° and 20° C. if the relation still held. This would mean that the differences between the milk samples used affected the temperature coefficient only, and that therefore, for example, the contents of calcium ion were equal. The fact that a very small quantity of calcium exerts such a large effect suggests that the quantity of ionized calcium originally present is very small.

It is thought that the observations recorded here will provide a means by which many factors controlling milk coagulation may be studied, and that the hypothesis put forward may be of use in such investigations.

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National Institute for Research in Dairying,
University of Reading.

[1] Holter, H., *Biochem. Z.*, **255**, 160 (1932).

[2] Linderstrøm-Lang, *Z. physiol. Chem.*, **176**, 76 (1928).

[3] Brigando, J., *Lait*, **13**, 657 (1933).

[4] Effront, J., "Biochemical Catalysts in Life and Industry", (New York, 1917).

[5] Chick and Martin, *J. Physiol.*, **40**, 404 (1910).

[6] Berridge (unpublished).

Lowland Tropical Podsols in Uganda

RICHARDS has stated[1] that there are indications, though no definite evidence, that lowland tropical podsols are found in Africa. Such soils appear to exist in one small area of Uganda, near Lake Nabugabo, which is adjacent to the north western corner of Lake Victoria (lat. 0° 20′ S., long. 30° 50′ E.). These soils, which are just above the level of Lake Victoria (altitude 1,135 m.), are derived from recent lake deposits of sand. The deposits are poor in bases, like the sands of tropical Asia and tropical America from which podsols have been formed: the poverty in bases is reflected in the composition of the water in Lake Nabugabo, where the alkaline reserve varies between 0·00027 and 0·00029 normal, as compared with the average figure 0·0012 for Lake Victoria[2].

Analyses of the Nabugabo soils are not available and cannot be undertaken at the present time, but there seems no doubt that they must be regarded as podsols; they are very acid in reaction; the surface layers are dark with organic matter and there is a layer of bleached sand in the subsoil. In the hollows well-marked peaty deposits have developed.

Some of the plants in the peaty hollows at Nabugabo have been recorded from other swamps; for example, the tall grass *Miscanthidium violaceum* Robyns, which is common there, is dominant in many swamps in the west of Uganda. Several species, however, have been found in no other locality in the Protectorate. The most notable is *Sphagnum macromolluscum* Dixon, dominant over an area of some acres at Nabugabo but not known to occur anywhere else. Other species of Sphagnum are common on some of the mountains, but there is no record of them at altitudes below 3,000 m., with the exception of *Sphagnum Franeonii* Warnst[3].

Many species of Utricularia also are found at Nabugabo, among them being *Utricularia appendiculata* Bruce, *U. erecta* Kam., *U. exilis* Oliv., *U. exoleta* R. Br., *U. Kirkii* Stapf, *U. obtusa* Sw., *U. prehensilis* E. Mey., *U. reflexa* Oliv., *U. spiralis* Smith, *U. stellaris* L., *U. subulata* L., *U. Thonningii* Schumach. The genus Utricularia does not seem to be so well represented at any other place in the Protectorate, although some of these species have been found at much higher altitudes on the mountains.

Trichopteryx gracillima C. E. Hubbard is another species recorded from the peat logs of Nabugabo but from no other locality in Uganda. *Drosera Burkeana* Planch. also has been found nowhere else in Uganda, but *D. madagascarensis* D. C., which is more abundant at Nabugabo, is also more widely spread.

The type specimens of several of the species enumerated above have been collected in recent years at Nabugabo and, therefore, it seems probable that similar deposits of peat at low altitudes are not very common in tropical Africa. No other striking examples of lowland podsols have been noticed in Uganda, nor is it to be expected that they would occur: for nowhere else at low altitudes is there the same combination of a climate with a heavy rainfall and of soils made up of leached sands. Eggeling[3] has suggested that at low altitudes in Uganda the Sphagnum community develops only where the natural succession is upset and cites other examples where it has occurred in annually burnt Miscanthidium swamps.

Miscanthidium violaceum is dominant in many swamps in the west of Uganda, and scattered plants of Sphagnum, Utricularia and Drosera are often found in association with it. The soil reaction in these swamps is always very acid but the subsoils, when tested by the chemical section of this department with Comber's reagent, have given a bright red colour, showing that the iron had not yet been leached out.

Crocodiles, which are abundant in Lake Victoria, are absent from Lake Nabugabo. The reason has remained a complete mystery. Lake Nabugabo was formed when a sand spit shut off a bay of Lake Victoria, and at the present time it is separated from the larger lake by a stretch of level ground, only three quarters of a mile wide, which could easily be crossed by crocodiles. Yet no crocodiles have been seen in Lake Nabugabo, although the temperature of the water and the supply of fish would seem to be favourable to them.

It is possible that the water of the lake which, near the eastern shore beside Lake Victoria, has a faint peaty smell and is acid in reaction, may be so distasteful to crocodiles that they avoid it. If this is the case, it is an interesting example of the complexity of the ecosystem, in that the character of the soil has controlled the distribution of so large an animal as the crocodile.

A. S. THOMAS.

Department of Agriculture,
Kampala,
Uganda.
Oct. 5.

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[1] Richards, P. W., NATURE, **148**, 129 (1941).

[2] Worthington, E. B., "A Report on the Fisheries of Uganda" (London, 1932), p. 64.

[3] Eggeling, W. J., *J. Ecol.*, **23**, 430 (1935).

Value of Molybdenum for Lettuce

IN the course of work on the minor element constituents of Chilean nitrate, the value of molybdenum in improving the growth and health of lettuces has been apparent. With one part of molybdenum (as sodium molybdate) in ten million parts of nutrient solution the plants are larger, deeper green and appear to be much more resistant to disease. This improvement occurs whether the molybdenum is used alone or in conjunction with one or more other minor elements as strontium, titanium, vanadium, chromium and zinc. Preliminary experiments even suggest that molybdenum can fend off symptoms of boron deficiency for some time in the early stages of growth, but this point needs confirmation.

If molybdenum in such small doses can definitely be shown to render lettuces less susceptible to disease, it may prove to be a valuable asset to commercial growers, whose losses from various causes are very considerable.

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K. WARINGTON.

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Rothamsted Experimental Station,
Harpenden, Herts.
Jan. 26.

Sociological Research in Race Relations

IN the light of some present sociological research in the subject of race relations in Great Britain, may I be allowed briefly to endorse the general arguments advanced by Mrs. Neville-Rolfe in her article on "Biology as a Social Science"[1], and more particularly her paragraph on social biology in education?

So far as my present observations show, popular information in respect to problems of human heredity and human biology in general has barely advanced out of the stage of superstition in many aspects, and much confusion exists over the meaning of various terms of technical or semi-technical usage. Perhaps the most common confusion is in respect to the connotation of the word 'race'. This term is used and accepted quite freely as a synonym for 'nation', 'people', or any other similar concept for which an alternative noun cannot readily be found. There appears to be also a fairly wide and quite unanalysed acceptance of such conceptions as 'national psychology', etc., the logical implications of which are that an individual's cultural or social behaviour is 'inherited' much in the same manner as the colour of his skin. Further mysticisms surround the biological and social implications of the phenomenon of racial miscegenation, and that 'blood' itself fulfils the function less romantically ascribed to the genes is as usual an explanation of heredity as the existence of 'criminal types' and the 'science of bumps'!

The 'etiology' of this core of popular 'knowledge' need not be discussed here. The situation, however, plainly suggests that there has been something seriously amiss in previous educational policy. The moral would appear equally plain. Without a foundation of up-to-date information on such subjects it is not easy to see how the average citizen can face with any clarity the many complex problems that are involved in modern social and political policy.

K. L. LITTLE.

Thorneycreek Cage,
Herschel Road,
Cambridge.
Jan. 31.

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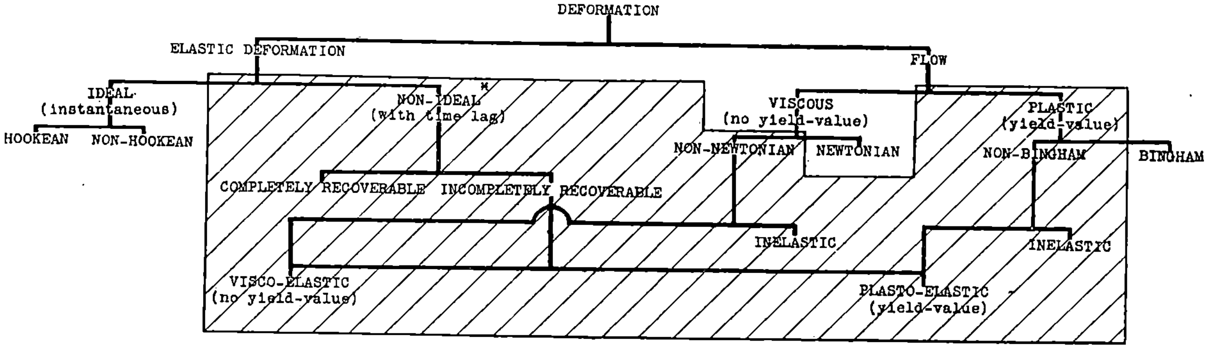
[1] NATURE, **149**, 90 (1942).

CLASSIFICATION OF RHEOLOGICAL PROPERTIES

THROUGH the courtesy of Prof. M. L. Oliphant, the British Rheologists' Club held a meeting at the Physics Department, University of Birmingham, on Saturday, January 24. After business proceedings, a discussion on "Classification of Rheological Properties" was introduced by Dr. L. R. G. Treloar, on behalf of the committee of the Club.

Dr. Treloar reminded members that at the annual general meeting of the Club, the question of definitions had been discussed and the committee had been instructed to draw up a tentative scheme for classification of properties of materials subjected to specific conditions, rather than to define terms many of which might not even approximate to the behaviour of real materials. This scheme, which was to be regarded as preliminary and subject to modification, is shown on the accompanying table.



WORKING DEFINITIONS

Elastic Deformation—recoverable deformation.

Flow—non-recoverable deformation.

When flow starts only above a critical stress (**Yield-Value**) it is **Plastic**. When flow starts at all stresses, however small, it is **Viscous**.

Hookean—obeys Hooke's law, stress proportional to strain.

Newtonian—obeys Newton's law, stress proportional to rate of shear.

Bingham—obeys Bingham's law, rate of shear proportional to stress less yield-value.

An elastic deformation is **Ideal** when the whole of it follows immediately on the application of a stress. When it does not, it is classed as **Non-Ideal**.

Note. Categories within the hatched area are liable to change of rate of deformation under constant stress, the rate either increasing or decreasing.

* In the case of a spring and dash-pot in parallel, the system could obey Hooke's law if the stress were applied sufficiently slowly but not if it were applied fast. In some other systems a direct proportionality between stress and strain is not obtained however slowly the stress is applied.

Deformations are conveniently subdivided into elastic deformations and flow, the former being generally defined as 'recoverable' and the latter as 'non-recoverable'. Recoverable deformations are subdivided into those which are 'ideal', in which a definite strain occurs immediately on the application of a stress, and those which are non-ideal, showing a time lag. Ideal deformations may be Hookean (that is, directly proportional to stress) or non-Hookean. By definition, ideal deformations are completely recoverable, but non-ideal deformations may be either completely or incompletely recoverable. The latter give rise to visco-elastic deformations corresponding to systems which show no yield-value, that is, the smallest applied stresses produce a deformation.

Flow may be viscous (no yield-value) or plastic (yield-value). Here Dr. Treloar stressed the fact that postulating such categories does not imply that it is believed that real materials follow these definitions *exactly*. We need not suppose that any material shows a *perfect* yield-value; still less that there are any perfect Bingham systems in Nature (that is, systems which flow at a rate strictly proportional to the excess of the applied pressure over the yield-value). These categories are of use in giving a practical approximation to the behaviour of real materials.

Deformations which are produced only after a yield-value has been exceeded but which do not obey Bingham's law may be subdivided into inelastic and plasto-elastic; the latter differs from visco-elastic only in showing a yield-value.

Returning to viscous systems which show no yield-value, these may show Newtonian (rate of deformation proportional to stress) or non-Newtonian flow. The latter group subdivides into inelastic and visco-elastic, thus re-merging with the elastic group.

The table should also be extended in another dimension to allow for the fact that, for example, under constant stress, the rate of deformation of many materials accelerates (thixotropy, false body, etc.) or decelerates (work-hardening, dilatancy). Detailed subdivision of these properties has not yet been attempted by the committee but, so that the importance of such properties should not be forgotten, all categories for which such behaviour is not precluded by definition are included in a hatched 'frame'.

Dr. Treloar concluded by expressing the hope that members would criticize this table freely both with respect to suggested alterations and additions.

Dr. G. W. Scott Blair, honorary secretary of the Club, said that he thought members ought to know how much the committee owed to Dr. Treloar for his contribution to the preparation of the table. He had only one other point to make, namely, that those who worked in specialized fields would doubtless find the table still inadequate in the special parts which concerned them. For the present, a number of phenomena which are known to exist have been omitted since they are not of great practical importance, and it is hoped for the present to keep the table simple. Thus, just as rate of deformation can increase or decrease at constant stress, so the partial differential of strain with respect to stress can likewise increase or decrease with stress considered at any given time. This would necessitate a second frame and a further subdivision of the 'non-ideal' category, but the committee believes that this is best not included for the present.

Mr. van Someren suggested that it would be helpful if each category could be considered in turn, and suggestions offered by members (not for inclusion in the table) of materials which would, under specified conditions, approximate in their behaviour to the category in question. This was done, though in some cases the suggestions were tentative.

There was some discussion on the meaning of 'recoverable' as applied to deformations. Dr. Scott Blair pointed out that the committee meant by 'recoverable' that the energy causing the recovery must be part of that originally applied and stored potentially, whether the recovery is spontaneous or initiated by some outside agent such as heat, mechanical or supersonic vibration, etc. Some members felt that 'recoverable' should be subdivided into 'spontaneously recoverable' and 'recoverable by activation by some external agent'. No final decision was reached and the committee was asked to consider the matter further.

A member raised the question of 'seepage' when the composition of a material is altered as it is deformed, and Mr. J. C. Gage pressed the point that many complex properties such as thixotropy, false body, dilatancy, etc., have not yet been dealt with in the classification. Dr. Scott Blair said that the committee was grateful for such comments and would bear them in mind, and Dr. V. G. W. Harrison asked that members should express freely any views they might hold, especially about any important omissions in the table.

Mr. van Someren pointed out that, at the top of the table, elastic deformations appear on the left and flow ('liquid') properties on the right; whereas at the bottom, the plasto-elastic deformations, implying yield-values, a property of solids, are now on the right, and the visco-elastic on the left. The committee might consider some slight modification of the table by which this apparent anomaly might be avoided.

Mr. Maunder Foster stressed the importance of the adhesive properties of many materials, and gave some account of the significance of this group of rheological properties in the boot and shoe industry.

Dr. T. L. Ibbs, who had presided during the meeting, concluded by saying that, as a non-rheologist, he appreciated the simplicity of the table. It was easily understood by those who were not highly specialized in rheology, and he, for one, hoped that this simplicity might be maintained.

Following the discussion, it was unanimously resolved to accept the table of classification as a basis for further discussion.

Dr. G. W. Scott Blair then read a paper on "Rheological Developments Past and Present", illustrated by lantern slides. A number of members also showed apparatus and materials of rheological interest.

G. W. Scott Blair.

INVESTIGATIONS ON LIGHTNING IN NIGERIA

In a recent paper entitled "The Measurement of Lightning Voltages and Currents in Nigeria, Part 2, 1938–1939", read in London before the Institution of Electrical Engineers, F. R. Perry, G. H. Webster and P. W. Baguley record the details of an investigation on the magnitude of lightning voltages and currents on Nigerian high-tension transmission lines, and continue an earlier work commenced by one of the authors. Three-phase oscillographic and klydonographic records of voltages were obtained, together with magnetic link measurements of currents on pole and lattice-mast structures. In addition, continuous records have been obtained of the interchange of current between earth and atmosphere during weather disturbances. The investigation resulted in a large amount of data for statistical analysis, and the results derived are briefly summarized below.

Surges of all types were analysed and resulted in wide variety of wave shapes, having wave-front values varying from 0·2 to 65 microsec., and wave-tail values from 0·9 to 93 microsec., the lowest values being generally associated with flash-over conditions. In general, the ratio between the length of wave tail to length of wave front covered a limited range of 1·2/1 to 4/1, higher values being obtained on occasions, these ratios being practically independent of the wave front and tail magnitudes. These values were, for example, smaller than for the 1/50 microsec. wave usually adopted as the test standard.

A number of records of direct stroke voltages were also obtained, most of these being associated with power system faults caused by line insulation flash-over. In such instances, the complete sequence of events was not always apparent, but it has been found that the recording of voltages on all three conductors is preferable to single-phase recording, a more complete history of the phenomenon being obtained. In two cases, it was found possible to obtain wave-shape records of the constituent strokes of multiple-stroke flashes, resulting in evidence of the family resemblance of such strokes. Certain aspects of the oscillographic records of lightning voltages were confirmed by klydonograms, the data obtained from the latter, however, being less accurate, and, in general, not so complete.

Current measurements were made in the case of direct line strokes, the line in this instance being supported by tubular steel poles, and in addition, the current distribution in the members of a lattice structure was obtained; of these, one set of such measurements involving eighteen lattice masts still awaits analysis.

Pronounced double pulses were obtained in certain oscillographic records of lightning voltages, and the suggestion is made that these are dependent on the current pulses in the main return lightning stroke, as was the opinion of Malan and Collens. Many of the observations made at Kew have been confirmed by observations made by means of a point-discharge recorder, certain differences relating to storm activity being simultaneously revealed with a contrast between temperate and tropical zone storm conditions. It was apparent from these records that a more complicated form of a Simpson-Robinson storm model could advantageously be applied to the task of explaining point-discharge records of lightning phenomena.

Following upon an analysis and discussion of the data obtained, certain suggestions are made as to the lines upon which future investigation should be conducted, and it is suggested that a study should be made of the voltages produced by multiple-stroke flashes to transmission lines, and an attempt made to ascertain whether any relationship exists between voltage pulses and the predicted currents fluctuating in lightning return strokes. It is further suggested that these data could be got most efficaciously by combining photographic studies obtained by a Boys camera with simultaneous oscillographic records of the corresponding lightning surge voltages. Sudden fluctuations in the point discharge current magnitudes might easily be obtained by means of a cathode ray oscillograph, and synchronized records taken of the discharge current at two or more points situated on the storm track axis, and spaced about 3 miles apart. If the power lines should run at right angles to the storm, then the additional discharge points could advantageously be located along the line.

COMMON INDIAN GRASSES

An interesting volume which was "written at the request of the Forest Department of the United Provinces, India, who wished to have a manual which would enable forest officers to recognize the common grasses found in their forests, taungyas and plantations" has a much wider appeal and deserves a place among the books of everyone interested in the Gramineæ. Its low price should help to give it the diffusion it deserves*.

The author points out that the grasslands of India are what Tansley would call a biotic climax, and only exist and are maintained when there is a harmony between the climatic and biotic factors so as to prevent the formation of forest. As a consequence, forest officers need to regulate the grazing and burning of the grasslands under their management with care, since too little of either is as harmful as too much.

After a summary of the ecology of the grasslands of the United Provinces, the author briefly discusses the morphology of the Gramineæ and gives short but precise instructions for making detailed examinations of specimens. Two keys are included, the first being an artificial one dealing mainly with larger and more obvious characters and intended for the less specialized user. The second is based on C. E. Hubbard, and contains keys to all the genera and species with which the book deals, except that no key is included to the genera of the Maydeæ (possibly by an oversight) so that the user is not given a clue to the position of Chionachne and Coix. The author might have been bold and included them in the Andropogoneæ, since they are, as Bews says, little more than a sub-tribe of the former.

The rest of the work consists of descriptions of the species common to the United Provinces arranged alphabetically under the genera, each species having two descriptions, one of a more 'popular' type and the other of a more detailed technical character. The known and possible economic uses of each species are briefly mentioned. The ninety-two commonest grasses are described and the work is illustrated with sixty-four plates, most of the species being illustrated either by photographs of living plants or full-page drawings which show clearly their habit and more essential features, a task which is not at all easy with the grasses. The illustrations of Saccharum are especially good, though in some of the other genera a few more detailed illustrations of spikelet dissections would have been welcomed.

A number of small points detract from the work. Phraseology of the type "a feature which is made use of in separating these species", "The nodes are easily made out", "anker roots" (all on p. 19) and "Many species of the Andropogoneæ are collections of spike-like branches" (p. 20) tend to jar the reader. Again, the use of the word Gramineæ without its capital initial, twice in the introduction and occasionally elsewhere is not acceptable, especially as the author has no good reason for this and restores its capital later in the work. A number of plates have the bottom half an inch folded up as they are too large for the volume. This could have been avoided in most cases by a more careful placing of the figures, or even the titles.

However, these are only small defects: the book will be useful to anyone concerned with grasses and will provide good illustrations and descriptions of a number of most interesting tropical grasses not adequately treated in most text-books.

B. C. Sharman.

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*Common Grasses of the United Provinces. By N. L. Bor. (*Indian For. Rec.*, New Series. Botany. 2, No. 1.) Pp. vii+222+64 plates. (Delhi: Manager of Publications, 1941.) 9.14 rupees; 15*s*. 6*d*. net.

THE POTATO IN INDIA

The potato (*Solanum tuberosum*) is cultivated in India in the plains as well as in the hills. In the plains it is difficult to store the crop through the hot season. Hence seed in the plains comes from the hills or is imported. It is also difficult to hold potatoes in the plains in storage for table purposes owing to shrivelling, moth attack, wet and dry rots, high-temperature rot and sprouting. Potatoes after lifting will not sprout during a dormant period varying with temperature, variety and maturity at harvest.

Dr. D. V. Karmarkar and Mr. B. M. Joshi began experiments on the cold storage of the Indian potato in 1936, and their results are now published in Miscellaneous Bulletin No. 45 of the Imperial Council of Agricultural Research. The work was done under the Council's cold storage research scheme at Ganeshkhind Fruit Experimental Station, Kirkee. Below 35° F. dormancy was indefinitely prolonged. At 40° F. the maximum period of dormancy observed was nine months. Delay in placing potatoes at this temperature after harvest reduced the period of dormancy. There was no wastage at 40° F. or 35° F., but at lower temperatures, 30° and 32° F., the potatoes were injured after three months exposure. The injury was a blackening of the central tissues (black-heart).

The sprouting vigour of potatoes was not affected by extending the dormant period at 35° or 40° F. The growth and yield of crops grown from seed long stored at these temperatures may even be favourably affected. Black-hearted potatoes merely rot when used as seed.

This report, of which the main results are quoted above, is a sound piece of systematic scientific survey work of permanent value. It provides bed-rock data for agriculture and industry under Indian conditions, such as can only be acquired by years of organized effort. It is to be hoped that work of this character will be continued and extended.

Franklin Kidd.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public.)

Monday, February 16

Joint Meeting of Technical Societies arranged at the request of the Mines Department (in the Lecture Hall, Public Libraries, Sheffield), at 3 p.m.—Discussion on the Best Ways and Means of Promoting the Efficient Use of Fuel and Power in existing Industrial Plants under Present Conditions, and for Making Constructive Suggestions. (To be opened by Dr. R. J. Sarjant, Mr. H. C. Armstrong and Mr. Donald Wilson.)

Wednesday, February 18

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir John Russell, F.R.S.: "Post-War Agriculture in Great Britain".

Institute of Chemistry (London and South Eastern Counties Section) (at 30 Russell Square, London, W.C.1), at 4 p.m.—Prof. F. A. Paneth: "Artificial Radioactivity and the Completion of the Periodic System".

Thursday, February 19

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. H. J. Emeléus: "Fluorine".

Royal Institution (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Mr. John Henry Gorvin: "Some Aspects of the Post-War Feeding of Europe".*

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Mr. J. M. Meek: "The Electric Spark".

Friday, February 20

Association of Applied Biologists (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "Domestic Entomology".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Teacher of Physics (man or woman)—Principal, and Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby (February 20).

Waterworks Engineer and Manager—The Clerk to the Southport and District Water Board, Town Hall, Southport (March 7).

Advisory Entomologist for the Bristol province, under the scheme of the Ministry of Agriculture and Fisheries for the provision of technical advice for farmers—The Secretary and Registrar, Department of Agriculture and Horticulture, University, Bristol (March 9).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Institute of Industrial Psychology. Annual Report and Statement of Accounts for the Year ended 30 September 1941. Pp. 16. (London: National Institute of Industrial Psychology.) [191

Transactions of the Institution of Chemical Engineers. Vol. 18, 1940. Pp. v+147. (London: Institution of Chemical Engineers.) [191

Transactions of the Royal Society of Edinburgh. Vol. 60, Part 2, No. 14: Chironomid Larvæ of the Millport Shore Pools. By T. A. Stuart. Pp. 475–502. 3*s*. 6*d*. Vol. 60, Part 2, No. 15: The Life-History and Ecology of the Salmon Gill-Maggot *Salmincola salmonea* (L.) (Copepod Crustacean). By G. F. Friend. Pp. 503–542. 4*s*. 9*d*. (London and Edinburgh: Oliver and Boyd.) [231

Leicester Museum and Art Gallery. 37th Annual Report to the City Council, 1 April 1940 to 31 March 1941. Pp. 16. (Leicester: Leicester Museum and Art Gallery.) [22

University of Leeds: Department of Coal Gas and Fuel Industries, with Metallurgy. Report of the Livesey Professor (D. T. A. Townend) for the Session 1940–41. Pp. 24. (Leeds: The University.) [22

Other Countries

Radiations from Radioactive Cobalt: a Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. By Arthur S. Jensen. Pp. 8. (Philadelphia: University of Pennsylvania.) [91

Carnegie Corporation of New York. Report of the President and of the Treasurer for the Year ended September 30, 1941. Pp. xi+148. (New York: Carnegie Corporation of New York.) [91

U.S. Office of Education: Federal Security Agency. Pamphlet No. 80: Sources of Visual Aids for Instructional Use in Schools. Revised edition. Pp. iii+91. (Washington, D.C.: Government Printing Office.) 15 cents. [91

Proceedings of the United States National Museum. Vol. 91, No. 3121: The Mammalian Faunas of the Paleocene of Central Utah, with Notes on the Geology. By C. Lewis Gazin. Pp. 54. (Washington, D.C.: Government Printing Office.) [121

Publications of the Observatory of the University of Michigan. Vol. 8, No. 11: The Julius F. Stone Spectroheliograph for the Determination of Solar Atmospheric Radial Velocities. By Robert R. McMath. Pp. 141–147+7 plates. (Ann Arbor, Mich.: University of Michigan.) [112

U.S. Department of Agriculture. Miscellaneous Publication No. 424: A Classification of the Scale Insect Genus *Asterolecanium*. By Louise M. Russell. Pp. 322. 45 cents. Technical Bulletin No. 791: Hibernation of the Corn Earworm in South-eastern Georgia. By G. W. Barber. Pp. 17. (Washington, D.C.: Government Printing Office.) [121

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 29: The Chemical Processing of Indian Cotton Materials, Part 1: The Effect of Kier Boiling and Bleaching on the Cuprammonium Fluidity and Strength of Yarns spun from Four Good Quality Indian Cottons. By Nazir Ahmad, M. U. Parmar and K. Venkataraman. Pp. ii+18. (Bombay: Indian Central Cotton Committee.) 8 annas. [121

India Meteorological Department. Scientific Notes, Vol. 8, No. 95: Forecasting Monsoon Rainfall in Mysore. By V. Doraiswamy Iyer and C. Seshachar. Pp 117–130. (Delhi: Manager of Publications.) 10 annas; 1*s*. [121

Contributions to Embryology. Vol. 29, Nos. 179–186. (Publication No. 525.) Pp. 193+57 plates. (Washington, D.C.: Carnegie Institution.) 4.50 dollars. [121

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 141: A Soil Survey of the Waikerie Irrigation Area, South Australia. By R. I. Herriot and E. J. Johnston. Pp. 44. (Melbourne: Government Printer.) [191

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 2: Statistical Summary of Education, 1937–38. Prepared by Emery M. Foster. (Biennial Survey of Education in the United States, Chapter 1.) Pp. ii+40. 10 cents. Bulletin 1941, No. 1: Educational Directory, 1941. Pp. iii+52+52+130+78. Bulletin 1941, No. 3: Weekday Classes in Religious Education conducted on Released School Time for Public-School Pupils. By Mary Dabney Davis. Pp. vi+66. 10 cents. (Washington, D.C.: Government Printing Office.) [201

Union of South Africa: Department of Agriculture and Forestry. Science Bulletin No. 225 (Botany and Plant Pathology Series No. 2): Some Leaf-Curl Diseases in South Africa: (1) Leaf-Curl Disease of Tobacco, (2) A New 'Petunia'-Strain of Leaf-Curl and a Note on the Occurrence of a Leaf-Curl Disease of Hollyhock. By A. P. D. McClean. Pp. 70. (Pretoria: Government Printer.) 6*d*. [271

Ministry of Agriculture, Egypt: Plant Breeding Section. A New Wheat Variety "Mabrook". By Dr. J. Philp. Pp. 5. (Cairo: Government Press.) [271

Field Museum of Natural History. Botanical Series, Vol. 20, No. 4: Tropical Marine Algae of the Arthur Schott Herbarium. By Prof. William Randolph Taylor. (Publication 509.) Pp. 85–104+2 plates. 15 cents. Geological Series, Vol. 9, No. 1: The Aplodontoidea. By Paul O. McGrew. (Publication 510.) Pp. 30. 15 cents. (Chicago: Field Museum of Natural History.) [271

Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Eighteenth Annual Report, 1941. Pp. 6. (Boston, Mass.: Huntington Memorial Hospital.) [271

University of Bombay: Department of Chemical Technology. Annual Report, 1940–41. Pp. iv+27. (Bombay: University of Bombay.) [271

Classified List of Smithsonian Publications available for Distribution, December 1, 1941. Compiled by Helen Munroe. (Publication 3645.) Pp. iv+42. (Washington, D.C.: Smithsonian Institution.) [301

Proceedings of the United States National Museum. Vol. 90, No. 3107: Revision of the North American Moths of the Family Oecophoridae, with Descriptions of New Genera and Species. By J. F. Gates Clarke. Pp. 33–286+viii+48 plates. (Washington, D.C.: Government Printing Office.) [301

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 849–C: Geology and Ground-Water Resources of the Balmorhea Area, Western Texas. By Walter N. White, Hoyt S. Gale and S. Spencer Nye. (Contributions to the Hydrology of the United States, 1940.) Pp. iii+83–146+plate 11. 15 cents. Water-Supply Paper 849–D: Underground Leakage from Artesian Wells in the Las Vegas Area, Nevada. By Penn Livingston. (Contributions to the Hydrology of the United States, 1940.) Pp. iii–147–173+plates 12–17. 10 cents. Water-Supply Paper 866–A: Geology of Dam Sites on the Upper Tributaries of the Columbia River in Idaho and Montana. Part 1: Katka, Tunnel No. 8, and Kootenai Falls Dam Sites, Kootenai River, Idaho and Montana. By C. E. Erdmann. Pp. v+36+7 plates. 25 cents. Water-Supply Paper 868–A: Investigations of Methods and Equipment used in Stream Gaging. Part 1: Performance of Current Meters in Water of Shallow Depth. By C. H. Pierce. Pp. iv+35+27 plates. 55 cents. Water-Supply Paper 868–B: Investigations of Methods and Equipment used in Stream Gaging. Part 2: Intakes for Gage Wells. By C. H. Pierce. Pp. iv+37–75+plates 28–31. 15 cents. Water-Supply Paper 871: Surface Water Supply of the United States, 1939. Part 1: North Atlantic Slope Basins. Pp. xiii+603+1 plate. 75 cents. (Washington, D.C.: Government Printing Office.) [22

Catalogues

Calendar for 1942. (Newcastle-upon-Tyne: C. A. Parsons and Co., Ltd.)

Azozol for the Shock (Convulsive) Treatment of Schizophrenia Pp. 2. (Nottingham: Boots Pure Drug Co., Ltd.)

A Catalogue of Books and Periodicals on Entomology and Genera Natural History. (No. 595.) Pp. 32. (London: Bernard Quaritch Ltd.)

General Catalogue of Books. (Catalogue No. 659.) Pp. 92. (London: Francis Edwards, Ltd.)

The Colorimetric Determination of Oxidation-Reduction Balance Third edition, revised. Pp. 22. (London: The British Drug Houses, Ltd.

University College of Science, Physics Dept.
92, Upper Circular Rd, Calcutta.

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INTERNATIONAL ASPECTS OF RECONSTRUCTION

BEFORE the United States entered the War, the question of Anglo-American co-operation after the War and the implications of the fifth article of the Atlantic Charter were under discussion, and attempts were being made to face the more obvious difficulties which will confront the world in the years to come. Speeches by Mr. Attlee and Mr. Eden, as well as by Mr. Sumner Welles, revealed agreement not only on ultimate purpose but also on some of the measures by which those purposes should be pursued. Mr. Eden's broadcast following his visit to Moscow showed that the confidence entertained that the Soviet Government will fully support those purposes and measures is well founded. Moreover, the announcement made by President Roosevelt during Mr. Churchill's visit to Washington that all barriers to the full pooling of reserves between Canada and the United States would be removed, in accordance with the recommendations of the Joint War Production Committee of Canada and the United States, indicates that unity of command in the military, naval and air operations is being accompanied by equal unity in the economic sphere.

The tendency to unity has thus been greatly accelerated by Japanese aggression, and the disturbance in the economic sphere arising out of the immediate Japanese gains in Thailand, Malaya, the Philippines and Borneo raises problems in the sphere of production and war economy no less difficult than those offered to war strategy and tactics in the military or naval sphere. Only concerted economic policy can enable the available resources of the free nations to be devoted to the maximum production essential for the overthrow of the aggressor nations. The effort and sacrifices required of every citizen in the nations linked together in the defence of freedom must be inspired by a common policy, just as the efforts of the armed forces must be guided by a grand strategy.

The Washington and Moscow conferences have clearly laid the foundations for such a policy in the prosecution of the War, and there are equally clear indications that concerted measures and policy will not be laid aside immediately the War comes to an end. There may be differences of opinion as to the extent to which effort can at present be devoted to planning while the war effort has still to reach its peak, but Mr. Churchill's speech to Congress shows that the lessons of twenty-five years ago are impressed on the minds of our leaders; that it is no empty hope, in the words of his peroration, that "the British and American peoples will for their own safety and for the good of all walk together in majesty, in justice and in peace". The urgent needs of war are fashioning habits and weapons of co-operation that it would be the height of folly to destroy before we have determined how far or with what modifications they might equally serve the purposes of peace.

Much indeed has happened to give impetus to Anglo-American co-operation since Mr. Harold Butler wrote so wisely and presciently of it in his brilliant book "The Lost Peace". Our hopes both of economic revival and of a stable peace rest largely on the assumption by the English-speaking countries of their responsibilities for leadership in a bold and broad spirit. Such leadership, in which constructive statesmanship, stimulated by the strong social consciousness manifest in both countries and in the Dominions, with as general objective not only the restoration of economic stability but also the progressive improvement of standards throughout the Continent, may well prove the surest way of consolidating our friendship and understanding with the Soviet Government, and of enlisting a degree of willing co-operation from the neutral as well as Allied Governments which would not be obtained by any political appeal.

Given both the general objective and the broad lines of policy, there are still many difficult problems to be resolved before even at the end of hostilities effective action in their furtherance is possible. There is the problem of the future of Germany inherent in the realization of such a common primary aim as that of ensuring that German aggression shall never endanger the peace of the world. There is the related problem of the basis of a system of collective security on which Mr. Butler writes succinctly and sagely. There are all the immense problems of restarting the economic life of the world, the planning of post-war industry, the reconstruction of world trade and the like, with the further complications in the way of supplies and diversion or redistribution of industrial activity which the outbreak of war in the Far East has already necessitated.

If we are not to be overwhelmed by the magnitude of so stupendous a task or engulfed in non-essentials and irrelevances, the clear recognition of ultimate objectives and of fundamental principles is essential. Only so can we keep a sense of perspective when we come to the discussion of particular intricate problems, as Prof. J. B. Condliffe has done in a recent admirable analysis of the reconstruction of world trade*. In its absence, a certain air of unreality is attached to some of the discussions on the machinery of international organization like federal union. Mr. Butler suggests that the British and American peoples will go farther and faster along the road together if they keep their national identities, than if they try to merge them in a common government, which would not be palatable to either. What matters most is in fact not the form of the machinery or organization but the spirit in which it is used. The machinery can be modified or shaped to reach the desired purpose, given the spirit and the will, but in their absence any machinery may be wrecked or left idle. That, as Mr. Butler sees it, is essentially the lesson of the last peace. For lack of will and lack of vision, organization which might have served the peace was never really used, and unless we can bring to the service of the new order of security and peace something which will inspire the coming generations with the same enthusiasm and the same spirit of sacrifice that the defence of freedom now evokes in the youth of so many lands in war, that new order will not be durable. In the great tasks ahead of us we have to enlist all the idealism and devotion of the best men and women in the world. As Mr. Butler reminds us, love and charity are the only foundations upon which a real civilization can be built, and a real and lasting peace will come only when the notion of service is expanded beyond national boundaries and foreign policy is guided by Oliver Cromwell's maxim: "God has not brought us hither where we are but to consider the work we may do in the world as well as at home".

From such a constructive idealism our plans and our lines of advance must start. With it must go the readiness to learn the lessons of the past and to shape new methods if the old or traditional ones are inadequate to our purpose. The sober realism that tempers Mr. Butler's judgment on the lost peace must guide our handling of the reconstruction that will begin when the War ends, and of the planning and preparation that must already be put in hand. We cannot postpone this realistic attempt to organize the economic and political life of the world on broader, more international lines. We can avoid the mistake of thinking of the world in nineteenth-century terms, which did so much to lose the last peace, and we can profit from the failure of our first experience in organizing the world for peace by reading its lessons aright.

Fortunately, much of our experience in the War itself is forcing us to recognize not merely the economic unification of the world under the pressure of technical progress but also the political consequences, just as organization being established to serve immediate war purposes is equally apt to serve those of economic relief after the War. We should recognize further not only that some new form of international organization is indispensable if war is to be banished, but also with that the extent to which our civilization still owes its vitality, its culture and its rich diversity to the national ideal. Sound opinions on vital aspects of post-war policy must, as an admirable report of the Committee on Reconstruction produced by the Royal Institute of International Affairs, issued for private circulation, points out, be based on accurate information, and much in the programme of inquiries suggested by the committee is relevant to the winning of the War. No policy based on reason can be consistently and effectively applied in the absence of a certain degree of unity and steadiness in the public mind.

It is the function of the discussions and inquiries proceeding to contribute to the formation of sound public opinion as well as to the maintenance of moral and the provision of a basis for policy and action at the right time. In all this, preservation of a sane balance is a first essential. A sane balance between town and country is a prime requirement in national policy and stability. Social equilibrium is the first requisite of political stability, and ultimately the political, economic and social security of nations depends mainly on the extent to which the conjugation of their national policies is calculated to prevent international disorder and secure economic stability. The reconciliation of both national and international needs under the stress of war is being effected under our eyes. It will issue in a durable peace when men, as in science itself, are the servants of some purpose capable of satisfying their spiritual instincts and setting them on a new adventure in the quest of higher things.

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* The Reconstruction of World Trade. By Prof. J. B. Condliffe. Pp. 427. (London: George Allen and Unwin, Ltd., 1941.) 12s. 6d. net.

DOMINATION OR RELATIONSHIP?

The Impulse to Dominate

By D. W. Harding. Pp. 256. (London: George Allen and Unwin, Ltd., 1941.) 7*s.* 6*d.* net.

ANY serious attempt to survey the psychological causes of war is noteworthy. But a work which leads logically and inevitably to the conclusion that war is inherent in our social pattern, relying as this essentially does upon dominative and prestige values, must challenge our best attention. In D. W. Harding's book, the author traces our individual failure in responsibility to two main problems. On one hand we need to become aware of certain unconscious tendencies which have fostered, and still maintain, the relation of domination or submission as the evolutionary ground-pattern in the development of our social and international relationships. On the other hand, the extreme complexity of the political issues of the great modern States makes it well-nigh impossible for the inexpert citizen, however intelligent, to participate responsibly in the crucial decisions of statesmanship. Since little can be done to reduce the latter factor to manageable proportions, the author wisely focuses attention upon those unconscious tendencies which can be largely modified through the cultivation of psychological responsibility.

Without minimizing the contribution which Freud and his followers have made in reducing the cause of war to the existence of infantile aggression and sadism, the author trims the balance by bringing into relief the basic dominative pattern which pervades our whole social atmosphere and which, therefore, must be regarded as a *representation collective* (Lévy-Bruhl), namely, an emotional preconception which everybody acts upon but nobody thinks.

Inasmuch as the author has called his work "The Impulse to Dominate", one could have wished for more enlightenment on the immense biological tail which civilized man has to draw after him in the realm of these archaic instincts. The general relation of the impulse to dominate to an underlying sense of insecurity is correctly stressed, but the perspective whereby this civilized mechanism is seen to derive its original dynamism from the primordial state whence, through the creation of communal solidarity, precarious solitariness was converted into a status of biological power and superiority, is strangely omitted. The author discusses Perry's anthropological evidence in support of the theory that violence is a cultural product and not, therefore, indigenous to our fundamental instinctual make-up. But Perry's contention that aggressiveness is a kind of diffusional accident is shown to be psychologically untenable, since it is impossible to believe that human beings could have built up a fundamental social structure which had no relation to their basal instincts. The fact that certain primitive tribes make violence their primary concern, while others, like the Eskimo, have produced an effective cultural breakwater against aggression, merely illustrates the difference of attitude with which the primitive mind has become adapted to a vital social problem. Perry's anthropological evidence is none the less significant. If the Eskimo have succeeded in creating a non-aggressive social pattern by a peculiar sense for communal responsibility, it is surely possible for us in the face of immediate necessity to cultivate the integrative pattern of relationship instead of the dominative. This fundamental change in attitude comes into the realm of the feasible, when it is borne in mind that the impulse to dominate is countered by its opposite, which might be called communal solidarity, or relatedness. When the one hypothesis leads us to the very brink of chaos, it is conceivable that a human migration towards the other pole will eventually create a sense of community among men in which the bare threat of domination will evoke instant response like that of the fire-alarm. The nation-wide discipline of fire-watching could even be regarded as a first step towards the development of a general attitude of responsibility in regard to the latent archaic potentialities in human nature. The author's insistence throughout the book upon the superiority of the integrative type of relation—based essentially upon a living feeling for human individuality—is supported by psycho-therapeutic experience. It is indeed in the cultivation of a relation of candour between patient and doctor, in which the distinctivenes and totality of the personality are unreservedly accepted, that the healing value lies.

From the psychological point of view, the only criticism of Harding's work that can be made (though a significant one) is the omission of any reference to the general dynamic determinants which are comprised in the various national myths. The myth of a people is more than a poetic heirloom. It is an incalculable storehouse of explosive energy, as we have seen to our cost in the resurgence of the tribal myth in Germany and Japan. The term 'pattern' is altogether too static and thin to comprehend the stupendous reserves of energy-potential which are evoked from the racial unconscious in times of national crisis. This omission is all the more singular inasmuch as the author's somewhat discursive review of the various regressive social phenomena of war-time, such as acquiescence, credulity, sadism, cruelty and sexual interest, demands just this comprehensive conception of the activation of the archaic unconscious to bring the total picture into a comprehensive focus. In point of fact, it was the abundance of similar evidence of archaistic social tendencies which led Jung in the first place to postulate the existence of a general unconscious. The author perceives the psychological inadequacy of the attempt to explain the war-time psyche from analysable factors in the personal unconscious, but he apparently recoils from the wider conception which could alone make it intelligible. The path which Trotter blazed during the War of 1914–18 in his "Instincts of the Herd in Peace and War" served us well for a time; but, since Trotter wrote, psychology has placed valuable tools in our hands which cannot be ignored.

Harding's work is compact and readable. If it has suffered from the exigencies of war-time economy, this necessary circumscription will make the book accessible to a larger public. It is a work that merits wide acceptance.

H. G. BAYNES.

THE ENDOCRINE ORGANS IN HEALTH AND DISEASE

Essentials of Endocrinology

By Dr. Arthur Grollman. Pp. xvi+480. (Philadelphia, London and Montreal: J. B. Lippincott Company, 1941.) 36*s*.

No science has developed more rapidly in recent years than that of endocrinology. This has been partly due to its great practical importance in relation to the study of disease, and it is noteworthy that many of the more important discoveries in this branch of science have had their origin in clinical observation. As Dr. Grollman points out, it is impossible to dissociate experimental from clinical endocrinology. Moreover, the latter can now be placed on a scientifically sound basis, for the organism is continually performing natural experiments the results of which can be followed up and correlated with other observed facts in such a way that conclusions of lasting value can be formed. It is the purpose of Dr. Grollman's book to bring together in one volume the results of all these observations and experiments for the average medical reader. At the same time, there is much in the work that makes a strong appeal to the general biologist.

The book is divided into five main parts. The first of these deals with the endocrine glands of the cranial cavity and more particularly with the hypophysis, which is a compound gland of great importance but not necessarily the 'master gland' of the endocrine system as some authors have conceived it to be. It is pointed out that certain disorders of hypothalamic origin have often been ascribed to the pituitary. Thus the well-known 'fat boy' condition may be hypothalamic. Nevertheless, the fact that stimuli of various sorts applied to the hypothalamus may affect the functions of the anterior pituitary, both positively and negatively, is evidence that hypothalamic lesions or defects may very often make themselves evident by interfering with pituitary function. In this part of the book the diseases ascribed to pituitary influence are well described and illustrated.

The second part deals with the branchiogenic organs and contains admirable accounts of the thyroid and parathyroid glands and the diseases arising from their dysfunction. The thymus is also included in this part, and after carefully considering the evidence, the author comes to the conclusion that none of the theories which have been put forward to explain its function are based on adequate experimental data or any plausible foundation. Some of the experimental evidence is contradictory as, for example, the claim that irradiation of the thymus in rats causes testicular atrophy, and the conclusion of Noel Paton that thymectomy tends to produce testicular hypertrophy.

Part 3 of the book is upon the endocrine organs of the abdominal cavity, namely, the 'islet' tissue of the pancreas and the medulla and cortex of the supra-renal. The pathology of these organs and their relationship to other organs and structures are well described, and much useful information is given concerning the treatment of the diseases connected with these organs. In dealing with the adrenals, there is a short account of their comparative anatomy throughout the vertebrates, but there is no mention of Swale Vincent, to whom much of our knowledge was due.

The fourth part, which concerns the reproductive system, is the least satisfactory in the book. Heape's original terminology used in describing the phases of the œstrous cycle is adopted with some modifications, but his name is not mentioned and the modifications do not make for increased accuracy. Thus, the anœstrum and diœstrum are not identical, and the latter is scarcely a period of rest since it is actually an abbreviated pseudo-pregnancy occurring only in polyœstrous mammals, and the distinction between these and monœstrous animals is not made. Ovulation does not necessarily depend upon coition in the cat, since many cats ovulate spontaneously during heat and are polyœstrous. Besides the rabbit and the ferret, the thirteen-lined ground squirrel (among rodents) does not ovulate without previously copulating, as shown by Foster. Moreover, among primates, both man and monkeys, there may be non-ovulatory diœstrous cycles and there is evidence that occasionally in women coition may induce ovulation. There is no such thing as a diœstrous period in the dog. Animals, such as most ruminants in temperate countries, which experience œstrus in autumn, usually bring forth in late winter or spring without any postponement of the development of the embryo. There is no evidence of a physiological law that the right and left ovaries of mammals produce ripe follicles which discharge their eggs alternately, but as a matter of actual fact this happens more frequently than not in the cow as recorded by Hammond and in the mare as observed by Day, and so probably may happen in other mammals. The placental theory of parturition does not explain the phenomena of pseudo-parturition as seen in the bitch, the rabbit and the marsupial cat. The absence of any account of behaviour cycles in relation to recurrent sexual phenomena is a noticeable omission.

The work concludes with a short fifth part on hormones produced from primarily non-endocrine organs, with notes on invertebrate and plant hormones.

About the general usefulness of the book there can be no question. F. H. A. Marshall.

SCIENTIFIC CHILD-STUDY

Child Psychology

Child Development and Modern Education. Edited by Charles E. Skinner and Philip Lawrence Harriman, with the collaboration of Amy F. Arey, Lawrence Augustus Averill, Lorin E. Bixler, Elden A. Bond, John W. Charles, Lester D. Crow, Raleigh M. Drake, Clyde Hissong, Clarence E. Ragsdale, Gladys Risden, J. J. Smith, Brian E. Tomlinson. Pp. xii+522. (New York: The Macmillan Company, 1941.) 12*s*. 6*d*. net.

The dominant note of this book, and the justification of review in the pages of Nature, is its claim, consistently maintained throughout, to adhere to a strictly scientific treatment of its subject. Poets and philosophers long held the field in the treatment of childhood, but since Darwin's time the man of science has joined them. Even the man of science has sometimes succumbed to points of view that could scarcely be called scientific, and the progress of child psychology has been from armchair speculation to the careful experimentation which is the sole concern of the writers of this book. They have written for a wide though a definite public—for parents, students of education, members of administrative staffs in schools, institutions and children's hospitals, and "those public-spirited citizens who may like to keep abreast of developments in this field". More especially, their purpose has been to meet the needs of teachers' colleges and university departments of education. No important aspect of child development has been omitted, not even the religious aspect. Some readers may in fact think that the scientific spirit is upheld to the point of quaintness when they read that "religious education can give human life dignity and worth through God-orientation".

As the title-page emphatically shows, the book is of highly composite authorship, there being no fewer than fourteen contributors. In this respect it differs from other recent and highly approved American books on the same subject, notably those of F. D. Brooks and Ruth Strang. The writers were carefully chosen for the specific contribution each was able to make. All of them have established connexions with leading institutions of higher education, and all of them are deemed to be qualified, by training and experience, to speak with authority. Equal care has been taken to prevent overlapping, and in an appendix the threads are pulled together by means of a full outline of the contents of the book. Extensive bibliographies enhance its value as a student's manual. By way of comparison with the well-known treatises of A. Gesell, J. Piaget and Susan Isaacs, it may be added that each of these is the work of one hand, and that each of them is in the main the result of original observation and experiment.

The range of topics covered by the book is so wide that it is only possible here to attempt a representative selection. On the vexed question of human instinct, for example, the authors are, on experimental grounds, led to a position which is neither that of the psychologist who made a list of fifteen hundred, nor that of the psychologist who found none at all. To maintain, says one of them, as McDougall does, that the human mind has a number of inherited tendencies that are the essential motivators of human striving has strong appeal to many even though others find the evidence unconvincing. It may be added that a general acceptance of McDougall's position seems to have led to fruitful results in the realm of applied psychology. On the subject of intelligence tests justifiably high claims are made for the brilliant work done by American psychologists, but with the equally justifiable warning that "unfounded generalizations, dogmatic assumptions, and unscientific attitudes have done much to destroy confidence in intelligence tests as they are now used and interpreted". The chapter on children's learning contains needed criticism of the half-truth that practice makes perfect: mere hammering away with no motive except to please parent or teacher yields little benefit, and we should never lose sight of the fact that learning often takes place with great suddenness—which is again a question of motive. There is an excellent chapter on the play life of children, but how odd it seems to anyone who has followed American studies in education produced during the past half-century to find that poor old Froebel is now not even mentioned! Odd, but no doubt inevitable, for though Froebel may have been in the main essentially sound, his writings cannot bear the test of scientific scrutiny.

This book on child study has been produced by a strong team of contributors, and it has features which differentiate it from other comparable books. It should take its place as a standard work on the subject. That it is addressed primarily by Americans to Americans is, at this time of day, a good reason why it should be well received on the other side of the Atlantic.

T. RAYMONT.

ENGINEERING DESIGN

Practical Design of Simple Steel Structures

Vol. 2: Girders, Columns, Trusses, Bridges, etc.: a Text-Book suitable for Civil Engineers, Structural Engineers, Road and Railway Engineers, and Students at Universities and Technical Colleges. By Dr. David S. Stewart. Second edition. Pp. xiii+289+11 plates. (London: Constable and Co., Ltd., 1940.) 16*s*. net.

Machine Design Drawing Room Problems

By Prof. C. D. Albert. Third edition. Pp. xi+441. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 21*s*. net.

In its second edition, Stewart's "Practical Design"—one of the series edited by Prof. Moncur and known as the "Glasgow Text-Books"—has been largely revised and rewritten to bring it into conformity with recent specifications. A substantial part consists of the detailed calculations necessary in the complete design of girders, columns, trusses, portals and bridges, and here an innovation has been introduced by arranging the figuring and the explanatory notes on opposite pages. This permits the calculations to be followed through consecutively and gives the young designer a guide to the proper method of setting out his own calculations in an orderly and logical sequence.

The book exhibits the dual purpose of developing the principles and applications of structural theory and of inculcating in the reader's mind the importance of the successive steps in the working up of a complete design. Against the risk of mere calculations being regarded too dogmatically, the author maintains a just proportion as between theory, practical knowledge and mathematical processes.

Prof. Albert's book treats of quite a distinct branch of engineering design, but it is evident that it too has been written from the point of view that practical knowledge is of the highest importance in design. It requires a sufficient knowledge of kinematics, mechanics and drawing, and offers, in conjunction with a parallel lecture course, the complete material for a practical course of instruction in machine design. The examples with which it deals include a number of unusual problems such as an arbor press, the frame of a punching machine, and a thrustor brake and thus afford a welcome change. The designs of these and other examples are fully worked out from initial specifications set out in much the same terms as they would be received in the drawing office and so present the method by which each problem is reduced to its elements and then worked up into the complete design. The latter part of the book forms a store of valuable data essential to the designer of machines and, for this alone, many will find it an almost indispensable item of drawing office equipment.

GALILEO GALILEI, 1564–1642

By PROF. H. C. PLUMMER, F.R.S.

IF there is something noteworthy in every tercentenary, in the conjunction of two such events in a single year there is something far more remarkable. The death of Galileo and the birth of Newton are important enough when considered separately. A great man has played his part and leaves the stage ; or another enters on a career no less brilliant. Both episodes are impressive ; that one followed the other within a space of twelve months adds to the significance of both. The two lives cover the whole of the seventeenth century and by themselves make it illustrious. The period between the birth of Galileo and the death of Newton was longer—no less than 163 years—running from the year which also saw the birth of Shakespeare in the reign of the Tudor Queen Elizabeth to the death of the first Hanoverian king. If that were all, it would be nothing extraordinary ; old Parr himself, who is reputed to have joined the reigns of Richard III and Charles I, covered nearly as long a span in a single life. But the age of Galileo and Newton was marked by an altogether unusual development of the human mind, and though this growth was far from being the work of two men, none contributed more powerfully to decide the extent and direction of its course than these two.

At the end of the sixteenth century, when Galileo was receiving his own careful and liberal education, the state of abstract science must naturally seem backward in comparison with what it became a comparatively few years later. There is indeed a manifest difference of scientific outlook between this and the following century, when the Paris Academy of Sciences and the Royal Society came into existence. Scientific method is applied with greater assurance, superstition is less evident and in fact the modern spirit has visibly grown in strength. Something of the change can be attributed to men like Francis Bacon, but more to Galileo and the abler among his contemporaries and followers.

Not that science, as distinct from medical knowledge, had failed to make considerable strides in Europe. After the deluge in which Greek culture had been overwhelmed, the scientific tradition passed into the keeping of the Arabs, to return to Europe about the thirteenth century. The subjects of serious interest were few, and chief among them was always astronomy. Indeed, a knowledge of this science had never been altogether lost ; the Venerable Bede had some familiarity with it, owing to the importance of the ecclesiastical calendar with its lunar and solar elements. But the Alfonsine Tables, which with modifications supplied Europe with astronomical ephemerides for about three centuries, were based on the Ptolemaic tradition preserved by the Arabs. The first attempt to understand the Ptolemaic system properly was made by Peurbach and Regiomontanus in the fifteenth century, and it was then that systematic astronomical observations were initiated. The next century saw the real advance made by Copernicus, though to Tycho Brahe's persistent observations astronomy owes an even greater debt for precept and example. From this point the main thread of astronomy passed through the hands of Kepler on the way to Newton, but the influence of Galileo, though less direct and less obvious, was no less important.

Like other sciences, astronomy was cultivated not merely because it appealed to intellectual curiosity but also because it satisfied human needs, first by supplying the data for astrology and later providing for the purposes of navigation. It owed its pre-eminence to its dependence on observation ; for though the art of observing developed with painful slowness from a primitive state, and the necessity of continuous application was realized as slowly, the case of those sciences which depended on experiment was far worse. Some knowledge of optics had been preserved by the Arabs, and with astronomy returned to the ambit of European culture. But it was of a geometrical kind, and it is symptomatic of its slow development on the experimental side that in 1600 the law of refraction was still unknown and was not discovered even by Kepler a few years later. A theory of sound was widely cultivated as part of the art of music, in which Galileo inherited great skill from his father, Vincenzo Galilei. After Gilbert's work, progress in electricity and magnetism was to prove slow and intermittent. In fact, natural philosophy was far from covering the whole extent of physics in Elizabethan days and for some time after. But chemistry was still more backward, though preserved among the lore of the Arabs and valued as alchemy ; even Newton, who made extensive researches in the subject, was mainly interested in the transmutation of metals.

Thus in Galileo's day, while the observational science of astronomy was beginning to advance by appropriate method, the experimental sciences lagged behind largely because the conditions for success were not understood. Quite naturally the change is first seen in optics. Galileo did not invent the telescope, but the barest hint of its possibility set him to work with his own hands ; and his example was followed. It is noteworthy that Galileo, Huygens, Newton, Descartes apparently and Spinoza certainly, were all practical opticians, who made lenses with their own hands. Here also is another change. Tycho Brahe, Galileo, Huygens, Boyle and Newton, who were distinguished by manual dexterity and a genuine taste for manipulation, were all far removed by birth from the artisan class. It was necessary to clear such occupations from social and intellectual prejudices alike, and the example set by Galileo in this direction was the more effective because his lectures as professor at Padua attracted an audience of the most distinguished.

As an astronomer, Galileo by the introduction of the telescope created a new type, in which he was to be followed by Huygens and surpassed by the first Cassini. He was not a painstaking observer like Tycho, and he was not a profound analyst like Kepler. But among other things he discovered the four principal satellites of Jupiter and the peculiar character of Saturn, the structure of the galaxy, and from observations of the solar spots he determined the rotation of the sun. Such achievements naturally brought fame and fanned his own vivid scientific imagination. The results were not altogether fortunate. They roused the implacable hostility of the fundamentalists, and it was not in Galileo's nature to adopt a conciliatory tone. He was a master of the satirical style and he used it with incisive effect.

The issue has been often misrepresented as concerned with the Copernican doctrine. But by 1616, when the "De Revolutionibus" was placed on the Index and Galileo received his first warning, astronomy had outgrown that stage, thanks to the work of Kepler. In fact, the problem of planetary motion was on the high road to solution, and the question between Galileo and his opponents was of a much more elementary kind. Whether Galileo used the actual words "Eppur si muove" may be doubtful, but they express the point in dispute exactly. It was not the nature of the earth's motion which was the subject of controversy, but whether the earth moved at all. Two years after the death of Kepler in 1630, the climax was reached and Galileo was condemned. The retractation extorted by an abuse of ecclesiastical power must have been a bitter pill to a pious man, but nothing was to be gained by obstinacy. *Magna est veritas,* and science needs no martyrs.

Apart from the struggle for freedom in the expression of scientific opinion, astronomy did not provide the field for Galileo's most important achievements. He was a mathematician according to the standard of his age and an acute observer, but above all he was an experimental physicist at a time when a pioneer in that capacity had an unequalled opportunity. His was among the earliest work in thermometry. But Galileo's real eminence rests on the experiments on which he founded the science of kinetics and the laws of motion. From the days of Archimedes little advance had been made in a knowledge of statics, if indeed the point reached in his wonderful discussion of the stability of floating bodies had been so much as remembered. But the notions entertained about the motion of a projectile were, before the days of Galileo, fantastic. By observations of the pendulum, of bodies in free vertical descent, of motion on an inclined plane and of projectiles under gravity, Galileo discovered the composition of velocities, the nature of uniform acceleration and the main principles of dynamics. For the first time the laws of motion were stated with fair precision, though the principle of momentum may have been defined more clearly by Descartes a few years later. A considerable advance was reserved for Huygens, who prepared the ground for Newton, but the essential steps had been taken by Galileo. There can be no happier example of the fruitful combination of well-contrived experiment with penetrating reasoning, for it was a virgin field which was brought under cultivation, and it is impossible to estimate the magnitude of the harvest in the form of practical benefit or in the domain of thought.

The effect on the progress of mathematics deserves particular consideration. Among the items of Greek culture which passed into the keeping of the Arabs, mathematics occupied an important place. They did more, as the very word 'algebra' suggests, and as the arithmetical scale of notation proves, than keep the science alive. But in the three or four centuries before Galileo's time the improvement had not been greatly accelerated on European soil. Geometry remained very much at the point reached by the Greeks, and few went nearly as far as that. Far more signs of life were shown by algebra, and Viète in France, Cardan in Italy and Harriot in England had made considerable advances, while Napier in Scotland had added the logarithm to the list of recognized functions. On the other hand, mechanics were confined to problems of statical equilibrium, and with this went a limitation of algebra to constant quantities and indeed almost entirely to positive constant quantity. Not until the consideration of the moving point and the relation of displacement in space to time was the notion of a variable quantity vividly presented. From that moment algebra and geometry developed into analysis. Thus the germ of infinitesimal calculus and all that is most important in modern mathematics can be traced to the demands of kinematical problems and therefore to Galileo.

Among his pupils two in particular deserve to be mentioned. There was Torricelli, mathematician and brilliant experimenter, who was the founder of hydrodynamics. There was also Cavalieri who, by developing the method of exhaustion of the ancients into the method of indivisibles, founded that Italian school from which James Gregory drew a part of his mathematical descent. Though not his pupil, Descartes was another who found in Galileo's work the source of those fertile ideas which affected the development of mathematics profoundly. Thus coordinate geometry was derived directly as the natural expression of the resolved motion of a point. It led not only to the representation of a curve by a relation between ordinate and abscissa, or from geometry to algebra, but conversely from algebra to geometry by the graphical representation of an equation. Hence the rapid development of the theory of equations which followed, together with the growing sense of generality when the relation of positive and negative quantity was appreciated.

In spite of his recantation, Galileo personified the hero as man of science. He was not the greatest astronomer of his time, nor was he the greatest mathematician. His chief distinction was due to the originality of his work in mechanics. In his life the hour and the man were combined, so that natural philosophy marched forward on a broad front, inspired by a single mind. To appreciate what this means, it is only necessary to consider what progress in mathematics, astronomy and physics was made in the short half-century 1642–92, and then to reflect how the germs of this advance in all branches can be traced to the one brain, Galileo.

In his search for scientific truth as he saw it, Galileo was clear-eyed and free from any scruple. He had expressed himself so candidly and his recantation was so plainly hollow, that it is hard to see what satisfaction his enemies could extract from his humiliation. Yet his attitude to science should not too easily be taken for granted, for it is very far from that which is accepted universally and without dispute. Perhaps the dangers of science have never been so widely proclaimed as at the present day, but they have always been felt, and by various methods it has been sought to mitigate them. Pythagoras and his followers found their method in the restriction of their knowledge to a band of initiates sworn to secrecy, who committed nothing to writing. Thus science was limited to the select and privileged few. The enemies of Galileo were actuated, so far as their aim was respectable, by the same motive—a dread of what would happen when Pandora's box was opened. But their remedy was altogether different from that of the Pythagoreans. What in effect they did was to maintain a system of error against a system of thought which was at least seeking fearlessly after truth. The result was disastrous, because the spiritual dangers which the more enlightened among them anticipated only too well could not be averted except by spiritual means, just as scientific error can only be met on the scientific plane. Changed as the circumstances may seem, the problem remains essentially the same as in the days of Pythagoras and in the days of Galileo. What would have been Galileo's answer can scarcely be doubted, for he was a great teacher as well as a great researcher. The function of science is to seek truth in its own sphere, regardless of consequences. At any stage, whatever the range of this knowledge won, it is necessary to adjust conduct in the light of the truth. The ethical problem is always the same; but the penalty of failure grows with the power which comes with increasing knowledge of the truth.

FOOD AND AGRICULTURE

At the afternoon session, on January 10, of the Conference on "Science and the War Effort", organized by the Association of Scientific Workers, Sir John Russell took the chair for the discussion of "Food and Agriculture".

Sir John Orr pleaded for the establishment of good will between different political parties in Great Britain and between the different countries of the world by all accepting Lincoln's revolutionary policy that countries should be governed by the people for the people. If Governments are going to govern for the people, their first duty is to provide the necessities of life for those people. These necessities are three: housing, clothing and health. We should plan for temporary housing for two or three years, and this should take precedence over the building of town halls, churches and schools. Our plans for food must be on a permanent long-range basis. We now know the human food requirements, and therefore we know the staple food supplies necessary for each country. More food than this would be waste; less, a waste of human life. We know that in peace-time this waste of human life occurs: in the United States only half the population enjoy sufficient of the protective foods to maintain them in health, and forty-five million people have a diet below the danger-line; and the standard of living in Great Britain is not much higher. If Governments adopted a food policy based on human needs, half the present disease and ill-health would be abolished. Such a policy could be used as a spear-head for trade prosperity and economic stability. Money would be needed; but such a policy would produce new real wealth, and we would be justified in creating credits. For this an international finance organization should be set up for trading in food. Scientific workers could get together to plan this and could say to the world: "We are planning for a post-war world in which every person will receive enough for health." Why have we not done so already? Great Britain should take the lead. We have done so much for the world; here is the next great step.

Prof. H. D. Kay discussed the application of science to the war effort in milk production and utilization. During the War the consumption of liquid milk has steadily increased: the consumption in 1941 was 25 per cent more than in 1938. Therefore, even if the supply of winter milk had remained at the pre-war level, there would have been a shortage during the winter of 1941. Actually, the supply of winter milk has only fallen by 2 or 3 per cent, and so most of the blame for the apparent shortage of milk this winter falls on the consumer. But this is no cause for satisfaction, since we have sacrificed eggs and bacon for milk; and we could have done much better than this had we applied science to dairying in Great Britain during the last few years. By the application of knowledge about breeding and feeding that is widely known—and applied in Denmark but not here—we could have increased the annual yield of milk by 30 per cent, and therefore could have supplied sufficient milk this winter with no increase in feeding-stuffs. There is a grave lack of training in scientific dairying among dairy farmers. With adequate training and the application of scientific principles we could attain what the climatic conditions of these islands and the character of these islanders allow us to attain—the best and most efficient dairying industry in the world.

Sir Daniel Hall considered the regeneration of farming as an economic industry. Farming in Great Britain is, by the admission of its own advocates, "down and out", and can only be kept going by isolation and protection from competition at a considerable cost in subsidies. These grants-in-aid have become substantial and by 1938 reached about forty million pounds a year; this figure must be considered in relation to the estimated value of British land, which amounted to £250 million—a very considerable proportion. The real objection to this policy is that the subsidies are not directed to improving the conditions or the methods of farming: we are giving alms instead of trying to set a poor man on the way to earning his living by removing the causes of his unsuccess. The majority of our farms are units too small to permit of the economies in working rendered possible by power machinery and of the improvements in methods that advances of science have shown to be practical. The two conditions necessary for the rehabilitation of farming are the expenditure of considerable capital in reconditioning the land, and then its apportionment into generally, but not exclusively, larger units. Since the landlords have proved unwilling to invest further in the upkeep of the land, this new capital can only be furnished by the State, and the State can only secure repayment by becoming the owner of the land. The dominant feature of the farming industry would then become large farming units working under conditions similar to those of other businesses, with a general manager, subordinates and other men with minor responsibilities to whom advancement was open. This nationalization of the land would regenerate farming as an economic industry and at the same time would bring into productivity much of the land, our national estate, which is now lying only partly utilized or even wholly waste.

The extent, causes and cure of malnutrition were dealt with by Dr. H. M. Sinclair. Evidence of the extent of malnutrition has been obtained from economic and dietary studies, and very recently from clinical and laboratory tests upon the population. These studies have not only shown the alarming prevalence of malnutrition but also defined the particular food factors most gravely concerned. Surveys have also shown to what extent the War has intensified the problem. Such surveys employing clinical and laboratory methods for the assessment of the state of nutrition of the population are now being made in various countries: in the United States (New York City, Duke University and Vanderbilt University), in Canada (Toronto), in France (Marseilles) and in England (Oxford Nutrition Survey). The study of groups of people living on diets of different quality has shown the effect of food upon health and physique. The incidence of different infectious diseases, for example, tuberculosis, bronchitis, diphtheria, in people of different income-groups is probably due largely to malnutrition, though other factors such as overcrowding are also concerned. Supplementing the diet of school-children has shown the effect of good food upon growth and strength; and recent work in Toronto has indicated that with proper feeding of poor women, maternal and infant mortalities can be greatly lowered. Very recent work with human volunteers on experimental diets has shown that slight deficiency of particular vitamins produces vague ill-health: lassitude, weakness, fatigue. The primary cause of malnutrition is poverty. Secondary causes are ignorance and the decreased availability of familiar foods. The cure lies mainly in increasing the consumption of protective foods. In peace-time, therefore, public health planning demands an increased production of those things that scientific agricultural planning encourages. The War has intensified and changed the problem; and in the period immediately following the War there will be world-wide famine. The British Empire, the United States, the U.S.S.R. and China should set up now an international committee of men of science to plan the adequate feeding of the allies during the War, and of the world when victory has been secured. The resources of agriculture alone are insufficient for both these tasks, and must be supplemented by new dietary sources of vitamins, minerals and possibly protein. In this task chemists have an important part to play. By their united action, men of science can abolish malnutrition and produce the greatest advance in public health since the introduction of sanitation.

Prof. F. G. Gregory emphasized the part that vernalization could play in increasing agricultural production. For example, it allows a catch-crop to be taken between the two main crops in the rotation, thereby permitting a much greater production of food from the land. The technique was first used in the U.S.S.R. and has been enormously developed there, but has attracted little attention in Great Britain. A recent Russian memorandum gives full details of the latest advances in vernalization.

Other examples of the failure of agriculture in Great Britain to make the best use of the results of research were given by Dr. A. Walton. Such research has mainly been directed to obtaining a priority value for the progressive farmer, who represents a very small proportion of farmers. Research is run by a complicated system with no less than seven bodies concerned: Parliament, the Treasury, the Development Commissioners, the Ministry of Agriculture, the Agricultural Research Council, the institutes of research and the research worker. The result is that there is a tremendous delay in the research worker obtaining the grant required for his work; and the research workers themselves, particularly the younger ones who actually do the work, are scarcely represented on any of those bodies. Fortunately steps have recently been taken to short-circuit this delay by the appointment of the Agricultural Improvement Council. In the rationing scheme for feeding-stuffs, and in artificial insemination, there has been lamentable delay. Dr. Walton's own work on the latter subject was repeatedly reported to the Ministry, and the Agricultural Research Council took the view that it was concerned with research and not with practical applications; when war broke out the reverse position was adopted—that artificial insemination was not immediately practicable, and therefore could not be given subsidies in any way. The result is that Great Britain, for the lack of perhaps a few hundred pounds expended six years ago, has lost some millions that might have been saved, and we are now more than ten years behind the U.S.S.R. in this matter.

From the chair, Sir John Russell drew the threads of these addresses together. In days gone by the conservation of the soil, and especially the preservation of the soil, was the farmer's sole purpose. He thought not only of to-day, but also of to-morrow; the soil had to last, and had to be available for the next generation. Then followed the long years' policy of cheap food, the farms lost numbers of workers, and those who came back to farming had no experience of arable farming. The soil decreased in fertility. Our system of agriculture postulated peace, because our diet required 1·6 acres a man, and therefore food had to be imported. But in Germany the national dietary had been adjusted to require only 1·1 acres a man, and so they could feed the majority of the population without importing food. We should aim at producing unstinted bread, potatoes and vegetables, and as much milk as possible. Wheat is compact, easily produced and easily transported; grain requires nitrogenous fertilizers which are available in this War. Germans consume twice the potatoes we do; and whereas our crop was previously produced in localized areas, it must now be distributed over the country to facilitate transport and increase consumption. But this scattering will introduce new problems such as the control of pests. We must, however, tackle and reduce the enormous waste produced by insect pests. The wire-worm has already done a great deal of harm in this War; it did much harm in the War of 1914–18, but it was not studied in the interval of peace. The flea-beetle destroyed winter crops needed for the production of mutton. Also we must tackle the rats—often the most intelligent things on the farm. Improvements in agriculture, brought about by increased research and the application of research, will help the spread of adequate nutrition and do much to abolish the evil of malnutrition.

PREPARATION OF PERSPECTIVE DIAGRAMS

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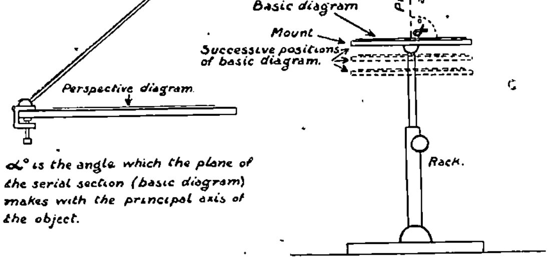
CONTOURED maps, serial sections, or plans and elevations, are capable of providing much detailed information about the form of regular or irregular bodies and surfaces. It is, however, not always possible, from an examination of such diagrams alone, readily to visualize the real shape of the surface and the relationships of the various parts, as the process of mental integration of the series of basic diagrams can often only be carried out after a prolonged study. Moreover, the formation of a complete mental picture, which can be easily used, may not always be possible. To overcome this difficulty, models of the surface may be constructed from the basic diagrams, and in most respects these constitute the ideal solution of the problem, since they can be viewed from many angles with ease. Unfortunately, such models are generally expensive and tedious to make[1,2,3,4], besides being fragile and not easily duplicated, and, when large, not portable. As a consequence, resort is frequently made to diagrams in which it is attempted, with varying degrees of success, to convey an impression of the third dimension. These diagrams have some of the virtues of models, and at the same time they are readily reproduced and stored.

Diagrams which give an impression of solidity and are prepared from contoured maps, serial sections or plans are of three types. The simplest types are orthographic projections, either on the plane of the basic diagrams or on some plane perpendicular to it. Their preparation has been described by Pusey[5], and their effectiveness depends to a large extent on the skilled use of shading. Wilson[6] has given an account of the production of the second or isometric type of diagram for mine workings. Such diagrams may be made by simple geometric methods, or with the aid of one of the instruments described by Lobeck[7] or de Sitter[8]. Although valuable, isometric diagrams have in many instances an unnatural appearance. The perspective diagram, the third type, has a more natural appearance, and is therefore to be preferred. Perspective diagrams can be constructed by geometrical methods[9,10,11] and McPherson[11] gives a computational method for transforming the co-ordinates of points on the surface to co-ordinates of points on the perspective diagram. None of these methods is wholly satisfactory for highly irregular surfaces, for a choice has to be made between plotting comparatively few points accurately and sketching between them, and laboriously plotting a very large number of points in order to define a line almost continuously.

Recently an instrument has been devised for the mechanical production of perspective diagrams from contoured maps[12], but it will not be easily or cheaply constructed, a drawback which is probably shared with any other mechanical devices which may have been invented. However, if a camera lucida (or other suitable optical arrangement) and a mount for the basic diagrams, set on the end of a graduated rack, or its equivalent, are available, perspective diagrams can be prepared by quite a simple method. A search of some of the scattered literature on the preparation of perspective diagrams has not revealed any previous reference to the method, in spite of its general applicability.

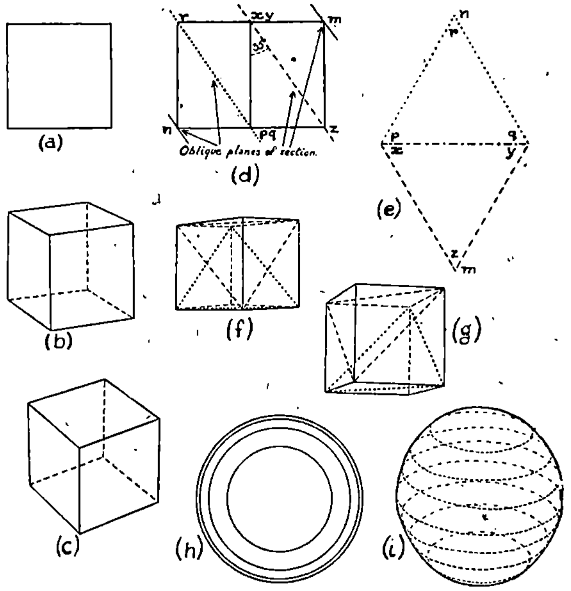
Fundamentally, the method merely consists of setting the serial sections or contours successively in the correct relative positions which they would occupy in or on the body, and drawing their appearance from a pre-determined viewpoint, with the aid of a camera lucida. In effect, the basic diagrams are made to describe the surface of which they are sections. The basic diagrams—contoured maps, serial sections or plans—if not of manageable dimensions, are first transformed to a readily usable size, that is, to a size in which the necessary lines can be seen and drawn without difficulty when viewed through the camera lucida. In the case of serial sections, it is not usually possible to transfer them to a single sheet of paper without leading to confusion, and hence they must be piled in their correct order and register. (In searching for published serial sections suitable for testing this method, it was found that they are figured without registration marks being included. Consequently, they are not immediately available for reconstructions either as models or as perspective diagrams. The value of such published sections would be increased by the inclusion of registration marks.)



$\alpha°$ is the angle which the plane of the serial section (basic diagram) makes with the principal axis of the object.

Fig. 1.

ARRANGEMENT OF CAMERA LUCIDA, RACK AND BASIC DIAGRAM FOR DRAWING A PERSPECTIVE VIEW OF AN OBJECT WITH ITS PRINCIPAL AXIS APPEARING TO BE VERTICAL.



The correct viewing distance is that with the eye twice this marked distance from the plane of the paper. The eye-level differs for the various perspective diagrams. In the case of (i), the top of the diagram should be two-thirds of the marked distance below the eye-level.

Fig. 2.

(*a*) Basic diagram for the construction of a cube in perspective. The plane of section is at right-angles to the principal axis of the cube.

(*b*) Perspective cube with axis vertical, derived from (*a*) by setting the basic diagram at two levels differing by a distance equal to the length of the side of the square.

(*c*) Perspective cube with inclined axis, and derived from (*a*). Instead of the basic diagram being horizontal as in constructing (*b*), it was tilted.

In making (*b*) and (*c*), the basic diagram was supported in a plane at right-angles to the axis of translation of the rack.

(*d*) Side elevation of symmetrically placed cube, showing the parallel planes of section.

(*e*) Basic diagram obtained by drawing, in their proper positions, the oblique serial sections taken along the planes shown in (*d*).

(*f*) and (*g*). Perspective cubes derived from (*e*). The same basic diagram could have been used to give perspective cubes for the types of positions shown by (*b*) and (*c*). The projections of the serial sections are marked to correspond with the appropriate parts of the basic diagram (*e*). In making these reconstructions, the basic diagram was supported in a plane making an angle of 35° with the axis of translation of the rack.

(*h*) Basic diagram for perspective sphere. The circles, in decreasing diameter, represent sections through a sphere at the following levels, measured from the lowest point on the sphere: $\frac{1}{2}R$; $\frac{3}{8}R$ and $\frac{5}{8}R$ superimposed; $\frac{1}{4}R$ and $\frac{3}{4}R$ superimposed; $\frac{1}{8}R$ and $\frac{7}{8}R$ superimposed, where R is the diameter of the sphere. (*i*) Perspective sphere reconstructed from (*h*). The drawings used to define the sphere's outline are shown dotted.

If the basic diagrams are on planes at right angles to the principal axis of the object, and it is desired to make this axis appear vertical in the perspective

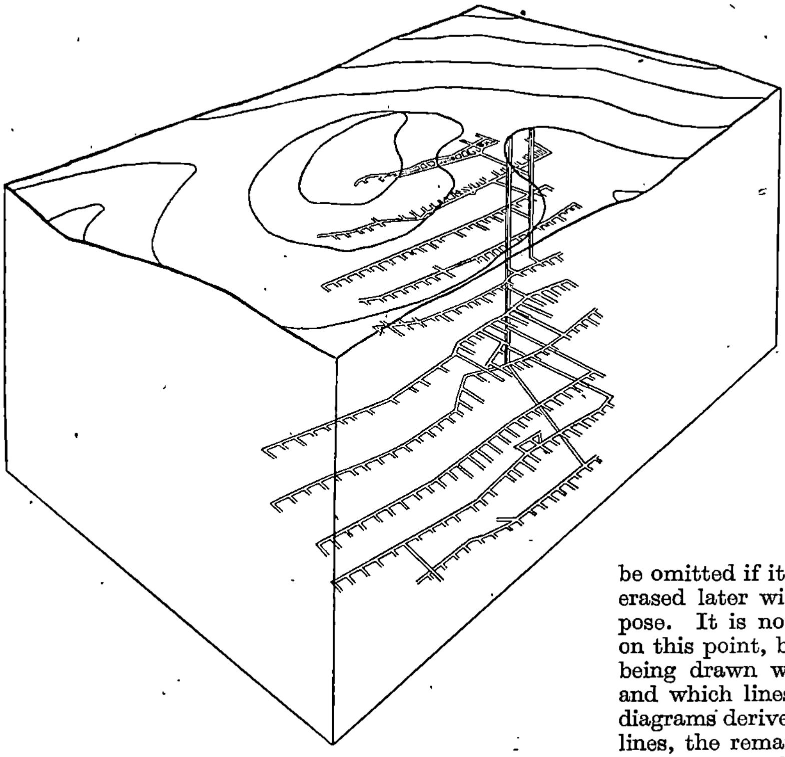


Fig. 3.
MINE WORKINGS, DRAWN FROM MINE PLANS.

diagram, the basic diagrams are mounted in a plane at right angles to the direction of movement of the rack and the latter is set to give vertical motion (Fig. 1). Having erected the camera lucida, the rack with mounted diagrams is placed so that the mid-point of the diagrams is at the appropriate distance from the camera lucida for the lens employed. The diagrams are then racked to a position at which the diagram of the highest contour or section can be seen satisfactorily through the camera lucida, and the basic diagrams are suitably oriented with respect to the viewpoint. Next the highest contour or the topmost serial section is drawn on a fixed sheet of paper while looking through the camera lucida. After removing the topmost section, if serial sections are being used, the mount is racked down by a distance corresponding to the contour interval or the distance of the second serial section below the top section, the distance being in terms of the scale of the maps or sections. The second section or contour next to the highest is now drawn, and all subsequent sections or contours are dealt with similarly. For some purposes it may be desired to magnify the vertical scale in the perspective diagram, although such magnification is not recommended as a general procedure, and should always be noted when used. N-fold magnification of the vertical scale involves racking down the mount N times the true equivalent of the contour or section interval.

In the case of maps, the intersections of roads, rivers or other features with a given contour are marked when that contour is drawn. Afterwards the points of intersection are connected together with the assistance, if needed, of intermediate points obtained by racking the map to inter-contour levels and marking the position of the feature at the corresponding height on the map.

In dealing with large diagrams or a series covering a considerable vertical range, the image of a diagram or of parts of one may not be perfectly focused on the paper on which it is to be drawn, but as a rule no difficulty will be experienced in drawing the image, and a slight uncertainty does not appear markedly to affect the final perspective impression.

After all the basic diagrams or contours have been converted to perspective projections, the outlines of features on the object are filled in by connecting related points, and those parts of the projections of the basic diagrams which are masked by the presence of part of the object between them and the viewpoint are erased or dotted as required. In making the camera lucida drawings, parts of the diagrams may be omitted if it is apparent that they will have to be erased later without having served any useful purpose. It is not possible to give brief general rules on this point, but a little consideration of the object being drawn will indicate broadly which lines will and which lines will not be needed. If perspective diagrams derived from maps are to retain the contour lines, the remainders of the contours are marked in more heavily, but with other objects the remaining lines of the projections of the basic diagrams should be used as a guide in shading, some direction of illumination being assumed, and ultimately erased, as a rule. Shading is of prime importance, for it removes the impression of flatness which is apt to persist in line drawings of curved bodies, permits the indication of features which cannot be shown by definite lines, and enhances the impression of solidity even in the cases of drawings of bodies bounded by sharp edges and plane surfaces.

If it is decided to 'look down' on the object, that is, to incline towards the observer the upper end of the principal axis which is ordinarily depicted as vertical, the rack, with the plane of the mount and

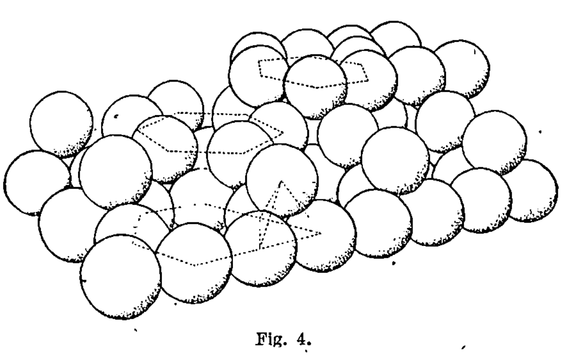


Fig. 4.
PERSPECTIVE DIAGRAM OF SET OF SPHERES SUCH AS MIGHT BE USED TO SHOW THE SPATIAL RELATIONSHIPS OF THE ATOMS IN A CRYSTAL.

Parts of the upper two layers have been removed. While no attempt has been made to depict a mineral species, it may be noted that the tetrahedral relationship of the spheres forming the bottom two layers would be that of the fundamental SiO_4 unit if a small sphere representing silicon were to be placed in the centre of each tetrahedral unit. The diagram was drawn from a plan view of the contoured spheres and a knowledge of the separation of the different layers of spheres vertically.

diagrams still at right angles to the direction of its travel, is inclined with its upper end towards the camera lucida. The procedure is then exactly as described above, and the same contour intervals are measured along the rack as when the principal axis was supposed to be vertical.

With sections cut at right angles to the principal axis of the object, the perspective diagrams which can be drawn with that axis vertical are those in which the object is appreciably below the eye-level (Fig. 2, *b*, *c*, *i*), for it is not possible to see the basic diagrams well when they approach the edge-on position. Perspective diagrams could also be drawn for the object above the eye-level, if the basic diagrams were mounted so that they could be viewed from below. However, if sections are available which, instead of being at right angles to the principal axis, are oblique to that direction, perspective diagrams can be drawn for the object in positions above, below, or intersecting the eye-level, provided that the obliquity is sufficient (Fig. 2, *b*, *f*, *g*).

In order to prepare perspective diagrams from oblique sections, the basic diagrams are mounted on the end of the rack at the same angle as they bear to the principal axis of the object. The construction is carried out in the same manner as for sections cut at right angles to the principal axis of the object. But it should be noted that the shift of the rack between drawing consecutive basic diagrams is equal to their separation along the principal axis, not to their separation at right angles to their own planes. The basic diagrams must be piled so that the points where the vertical axis cuts the separate sections are superimposed. As before, any orientation is possible which leaves the basic diagrams adequately visible. This modification is practicable with serial sections in palæontology, botany and zoology, but not directly with maps, since the contours are drawn on planes at right angles to the vertical (principal axis). Topography and geological structures are almost invariably assumed to be viewed from above for the purposes of diagrams, and as a result, the limitation in contour drawing is of little consequence.

In constructing perspective diagrams of complicated objects with closely spaced sections, the camera lucida drawing of each basic diagram should be in a different colour in order to reduce confusion, and the marking of features may be carried out by degrees, instead of after all the perspective projections of the basic diagrams have been drawn. It may even be necessary to make the camera lucida drawings on separate sheets of tracing-paper which are superimposed for the final reconstruction, or alternatively to make the drawings on sheets of ordinary paper provided with reference marks for use in tracing the essential parts from each sheet. The use of colours in the perspective diagram, with or without transparent overlays, may prove advantageous in showing internal features in complicated objects.

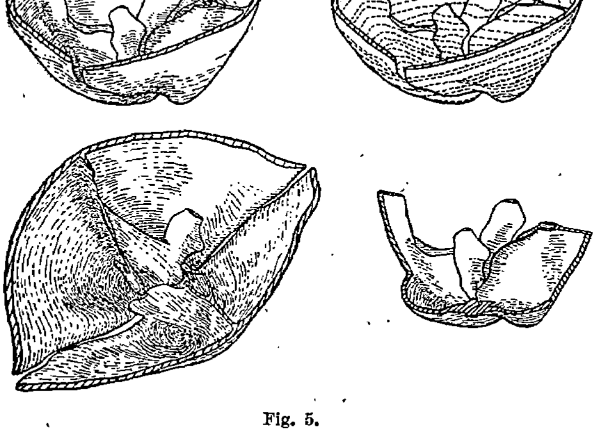


Fig. 5.

Parastrophina hemiplicata. PERSPECTIVE DIAGRAMS PREPARED FROM DRAWINGS OF SERIAL SECTIONS KINDLY LOANED BY DR. J. K. S. ST.-JOSEPH.

Comparison should be made with figures in the *Geological Magazine* (5), 78, 381 (1941). The upper right-hand diagram includes the contours which were used as the basis for shading.

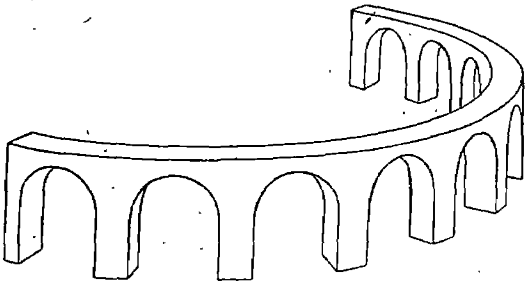


Fig. 6.

PART OF A CIRCULAR ARRANGEMENT OF ARCHES.

The drawing was prepared from the plan of the arches and a knowledge of the height and form of the individual arches.

Some experimentation may be necessary before the most satisfying view is obtained. Moreover, since the usual aim is to give a picture of the whole rather than of the details, it is more important to get the salient features in their proper relationship, balanced by a skilful selection of useful detail, rather than to copy all the detail meticulously, especially if it can only be fully appreciated on the original maps or sections, or if it will encumber the final drawing.

The size of the perspective diagram which can be produced directly by the present method is determined by the need to be able to look through the camera lucida and draw an image which is reasonably well focused. Diagrams about 25 cm. × 25 cm. are probably of the maximum size comfortably producible for a viewing distance of 30 cm. The method is probably used to the greatest advantage for approximately equi-dimensional objects, or those with a small vertical dimension and the other dimensions larger and about equal. Drawings of internal structures can be made with the same ease as those of the outer form. If models were used, such drawings would generally require either the construction of a special model or the partial destruction of the normal type of model.

For some types of basic diagrams optical arrangements other than the camera lucida may be used for producing the perspective views of the separate basic diagrams; for example, a photograph or camera obscura drawing may be made for each setting of the basic diagrams. In the case of photographs, the significant parts are afterwards traced, suitable reference marks being used to get correct super-imposition for each photograph. The fundamental idea of manipulating the basic diagrams is applied exactly as described for the camera lucida.

Perspective diagrams can be prepared by this method, or by means of Bain's perspectograph[13], for any body for which a series of parallel sections can

Basic diagrams	Perspective diagrams
Contoured maps.	Topographical perspectives, with drainage, roads, etc.
Stratum contour maps	Form of geological horizons, faults, etc.*
Mine plans.	Mine workings and the form of ore bodies (Fig. 3).*
Spatial relationships of atoms in a crystal, obtained from X-ray diffraction patterns.	Perspective diagrams of the positions of atoms in a crystal, with coloured or differently sized spheres representing the various kinds of atoms (Fig. 4).
Serial sections.	Palæontological, botanical or zoological objects (Fig. 5).
Plans for the various levels at which a change in form occurs.	Architectural and engineering structures (Fig. 6).
Sections for significant levels.	Engineering objects ; for example, pieces of mechanism, castings, lay-out of pipes, etc.
Series of curves relating two quantities, for different values of a third quantity.	Perspective view of the surface represented by the relationship between the three quantities, with or without the separate curves.

* These may obviously be combined with topography.

be obtained or easily constructed. The accompanying table summarizes some of the possibilities.

In conclusion, it may be recalled that perspective diagrams are prepared for one eye at a definite point, and hence they may not appear satisfactory even though accurately constructed, when they are viewed with both eyes and from a point appreciably different from that for which the diagrams were made. Consequently, the normal reading distance should be borne in mind when preparing perspective diagrams for publication. If they are drawn for a very different viewing distance, that distance should be indicated. Furthermore, in the case of very small objects involving the use of greatly enlarged sections, the resultant perspective diagrams may be somewhat unfamiliar because of the different angle subtended at the eye.

[1] Armstrong, F. W., *Trans. Inst. Min. Met.*, **41**, 106 (1931–32).
[2] Sollas, W. J., *Phil. Trans. Roy. Soc.*, B, **196**, 259 (1903).
[3] Uren, L. C., "Petroleum Production Engineering", 69.
[4] Bravinder, K. M., Sheldon, D. H., and Koogle, J. E., *Pet. Tech.*, Jan. 1941 ; *A.I.M.M.E. Tech. Pub.* No. 1271.
[5] Pusey, H. K., *J. Roy. Micro. Soc.*, **59**, 232 (1939).
[6] Wilson, W. H., *Trans. Inst. Min. Met.*, **43**, 545 (1934).
[7] Lobeck, A. K., "Block Diagrams".
[8] de Sitter, L. U., *Leidische Geolog. Med.*, **8**, 315 (1936–37).
[9] Lawrence, W. H., "Perspective", *Encycl. Brit.*, 14th Ed., **17**, 614.
[10] Sellar, W., Assoc. Engineering and Shipbuilding Draughtsmen, Tech. Sect. Pamphlets (1925–26).
[11] McPherson, G., *Trans. Inst. Min. Met.*, **47**, 347 (1938).
[12] Bain, G. W., *Econ. Geol.*, **36**, 71 (Jan.–Feb. 1941).

OBITUARIES

Prof. R. S. Seton

THE death of Robert Sutherland Seton in Leeds on January 12, at the age of seventy-four, will be deeply regretted among the agricultural educationists in Great Britain. Seton was a native of Watten in Caithness and became a student of agriculture at Edinburgh under the late Prof. Robert Wallace: he graduated in 1894 and then studied chemistry for a time at the Royal College of Science in London. After holding appointments at the Downton Agricultural College and the Harris Institute, Preston, he was appointed in 1900 to the chair of agriculture at Leeds, where he remained until he retired under the age limit in 1932.

As a teacher he set a very high standard in the personal attention that he gave to each student and to each applicant for admission to the agricultural courses. The written information on the form of application meant little to him ; he had to get hold of the individual and discuss with him in detail the problems of his training and his career. There will be many agriculturists at home and abroad who retain vivid memories of these first discussions and who are grateful for their beneficent influence. The successful careers of so many of his students will be in large measure due to the thoroughness with which he discussed their training with them at the outset and to his insistence on adequate practical experience before entering upon a university course.

While Seton was responsible for designing and carrying out many important field experiments, it was never his policy to adopt a special sphere of research as his own personal life-work. He was far more concerned to stimulate and encourage the work of his colleagues in all the various sections of his diverse department. He maintained a uniform interest in all branches of agriculture and the agricultural sciences, and no hour of the day or night was to him inopportune for the discussion of any piece of work going on in the department. He gave his time and help to his colleagues in this way without any concern for the recognition of his personal contributions to the work.

In the development of the advisory services of members of the staff among Yorkshire farmers, Seton did pioneer work. An advisory service whereby specialist officers are available to farmers is now established uniformly throughout Great Britain, but such a service was long before in existence in Yorkshire under Seton's direction and inspiration. In directing his colleagues in this advisory work he brought not only valuable help to the farmer but also considerable inspiration to the teaching in the Department by keeping lecturers in touch with practical problems.

The development of the Agricultural Department in Leeds in its teaching function, its research work and its advisory service will always remain as Seton's life-work. To this work he devoted an enthusiasm that remained undiminished to the end. Nevertheless he found time for other interests. The Board of Greenkeeping Research, on the committee of which he served, will remain indebted for the help he gave, and his influence was brought to bear upon agricultural education in Great Britain as a whole through his long and active membership of the Agricultural Education Association.

Seton will be remembered with great personal affection by all who worked with him and studied under him. N. M. COMBER.

Prof. J. P. d'Albuquerque

PROF. JOHN PEDROSO D'ALBUQUERQUE, who died at Ilfracombe on December 20 at the age of seventy-six, was a brilliant chemist.

From the City of London School he went up in 1885 to St. John's College, Cambridge, where he was for a time demonstrator to Prof. Liveing. Scholar, exhibitioner and Wright Prizeman, d'Albuquerque took first class honours in chemistry in Part I of the Natural Sciences Tripos in 1887 and again in Part II in 1889. It was predicted that he would attain high academic distinction in England; but he preferred to migrate to Barbados, having been offered in 1890 the post of Island professor of chemistry there in succession to Prof. Harrison, who had been transferred to British Guiana. Harrison and J. R. Bovell had recently discovered (or, as some say, rediscovered) the fertility of sugar-cane seed and had successfully raised seedling canes. This work was continued by d'Albuquerque in collaboration with Bovell, and many new varieties of cane resistant to disease which was decimating the Bourbon cane were made available. In 1898 d'Albuquerque assumed the additional duties of consulting chemist to the newly formed Imperial Department of Agriculture. As chemist-in-charge he was responsible for carrying out (still in co-operation with Bovell) an extended programme of experiments and research. Many published reports recording the results remain as a monument to his and his fellow-worker's industry, which exercised a profound influence on cane cultivation throughout the sugar-producing world and laid the foundations on which the present West Indian Cane Breeding Station in Barbados was built.

Between 1899 and 1909, d'Albuquerque acted as Imperial commissioner on numerous occasions. In 1910 Barbados seceded from the Imperial Department. A separate Department of Agriculture for the Colony was constituted with Bovell as head, and, after his retirement in 1925, d'Albuquerque was appointed director of science and agriculture. In that capacity he attended the Imperial Agricultural Conference in London in 1927. His activities were many. Besides performing the onerous duties of director, he remained in charge of science teaching at Harrison College, the Lodge, and Combermere School, and several generations of boys profited greatly from his teaching. He also reorganized the Government analytical laboratory, which was concerned not only with foods, drugs, and public health, but also commercial sugar analysis, a work which increased enormously as, thanks to his precepts, the planters became more scientifically minded. It is not too much to say that d'Albuquerque succeeded in revolutionizing the ideas of the planting community on the place and value of scientific research in tropical agriculture.

When in 1928 d'Albuquerque retired on account of failing health, Barbados was the poorer by the loss of a prominent scientific worker and a genial resident, who for nigh on forty years had identified himself with the social and official activities of the island which he had made his home.

d'Albuquerque was a keen Freemason. He was District Grand Master of the Barbados Lodge from 1906 until 1930 and a founder of the Caribbean Lodge. He was married in 1891 to Miss Beatrice Alice Langley, who with a son (a barrister-at-law) and a daughter survive him.

ALGERNON ASPINALL.

We regret to announce the following deaths:

Dr. Elsie C. Parsons, president of the American Anthropological Association, on December 19, aged sixty-six.

Prof. Hans Schinz, formerly professor of botany in the University of Zurich, aged eighty-three.

Prof. Virgilio Tedeschi, professor of biological physics in the National University of La Plata.

NEWS and VIEWS

Central Planning Authority

MR. ARTHUR GREENWOOD, Minister without Portfolio, announced in the House of Commons on February 11 that a Central Planning Authority is to be set up. Duties in connexion with town and country planning at present exercised by the Minister of Health will be transferred to the Minister of Works and Buildings, whose title will be changed to "Minister of Works and Planning". The newly styled Ministry will guide local authorities and will exercise the powers to be conferred by legislation arising out of the acceptance by the Government of the first report of the Uthwatt Committee, laying down the general principles to which planning must conform. The Secretary of State for Scotland will exercise corresponding powers in Scotland. The two ministers concerned will be assisted by committees of senior officials of the Departments on which their activities will impinge in order to secure consistent action throughout the country. By this means the Government hopes to secure the most appropriate development and use of the country, taking into consideration the recommendations of the report of the Royal Commission on the Distribution of the Industrial Population, and also the need for avoiding measures which would interfere with the over-riding aim of raising the standard of living to the highest possible level.

Lord Reith, who now becomes Minister of Works and Planning, made a similar statement in the House of Lords, amplifying it with an account of steps which are already being taken. The decision now announced, he said, implements the Uthwatt Committee's assumption of the early establishment of a central planning authority. Meanwhile, that Committee is now making an objective analysis of the subject of the payment of compensation and recovery of betterment in respect of public control of the use of land. Lord Reith's consultative panel has also been active. The Director General of the Ordnance Survey, Dr. Dudley Stamp and Prof. Eva Taylor are preparing maps for planning, showing physical features, land uses, movements of population, industry and communications. Lord Justice Scott's committee considering conditions which should govern constructional developments in rural areas is at work, as is also the inter-departmental committee co-ordinating the views of the various departments concerned. The latter has prepared a Bill to give effect to the recommendations of the Uthwatt Committee, and has considered long-term planning, the preservation of amenities, etc. His own group of special assistants has been responsible for the work of this committee and for the research which is the essential foundation of any scheme of national planning. In addition, the supply and standardization of materials have been under consideration, of necessity from the point of view of the war effort, but also with regard to the post-war implications. The central problem is to achieve the maximum benefit to the country of limited land resources available.

The Wartime Social Survey

ONE of the most recent developments in State research in the field of sociology is the Wartime Social Survey. After an initial period of growing pains, this Survey is now emerging as a valuable machine for conducting any type of inquiry capable of investigation by the method of interviewing samples of the population. Two Government Departments, the Ministries of Information and Food, required a market research machine for investigating the effects of their advertising. When the Wartime Social Survey was set up to meet this need, it became apparent that there were problems facing other Government Departments which could only be solved by the method of interviewing samples of the population, and to meet this need the Survey was extended. It now carries out investigations for not only the Ministries of Information and Food, but also for the Board of Trade, the Ministries of Health, Home Security, Works and Buildings, Supply and the War Office.

With the exception of its superintending research officer, none of its staff are Civil servants. This is one of an elaborate series of precautions adopted to make sure that the names of the persons interviewed are not available to the Civil Service. The headquarters staff consists of eight scientific workers, a number of coding tabulators, administrative officers, etc., while the interviewing staff consists of about fifty field-workers. So that this level of scientific work shall be as high as possible, a small panel of scientific consultants has been set up. They are Prof. A. M. Carr-Saunders, Prof. L. T. Hogben, Mr. B. Seebohm-Rowntree, Mr. A. D. K. Owen, Dr. Bradford Hill, and Dr. Aubrey J. Lewis. Every report produced is submitted in interim form to the consultants for critical comment before the final draft is prepared. Further, technical problems in the phrasing of questions, the selection of samples, etc., are submitted, particularly when any difference of opinion arises between a requesting Department and the scientific staff of the Survey. Owing to the speed at which war-time investigations have to be carried out, more detailed consultation is impossible, but the present system has shown that the needs of Government Departments for social survey investigation can be met by a Government-controlled machine without loss of scientific impartiality. Among studies recently undertaken are : the feeding of employed adolescents ; the methods of heating and cooking in working-class households ; salvage habits ; clothes-rationing problems ; food-rationing problems ; and a study of female foundation garments. It will be noted, of course, that this useful Survey is dealing with problems arising out of the War.

Nazism and Science

IN a recent Thinker's Forum pamphlet entitled "The Nazi Attack on International Science" (London : C. A. Watts and Co., Ltd., 6*d*.), Dr. Joseph Needham presents a brief but telling analysis of the nature of Nazism, and describes some of the effects it has produced in science and learning both inside Germany and outside. Society is now passing through an era of change from individualistic capitalistic economics to some form of collectivism, and just as the earlier change from a feudal aristocracy to capitalist democracy was marked by violent upheavals such as the Thirty Years' War and the French Revolution, so Dr. Needham believes that Nazism and Fascism are by-products of the present phase of the evolution of society. The necessary conditions are two powerful groups between which there are relations of mutual fear ; and the racketeer, in this case the Nazi, plays off one against the other. The Nazis have played this part successfully with the German people and also with other nations. Having attained power, the Nazis had to have "a nation of tools". This they achieved by the doctrines of anti-intellectualism, racialism, restriction of science to matters of military value, and the principle of the 'leader'. Incidentally, Dr. Needham points out that the war between China and Japan has its origin in a similar racial-national spirit which has arisen in the latter country.

Turning to biological fallacies exploited by the Nazis, Dr. Needham refers particularly to their misuse of the doctrine of the struggle for existence ; they overlook the distinction between inter- and intra-specific competition, forgetting that the latter has led to the development of unwieldy size, exaggerated fertility and other characteristics which in the past have brought about the extinction of the species concerned. They also make play with the analogy between the social organism and the animal body with its various organs or members. But associations of organisms capable of rational thought cannot be regarded as associations of living cells having only the primitive characters of life. It is a fundamental mistake "to suppose that higher levels of organization can be explained and handled in terms of lower levels". Dr. Needham recapitulates the facts already known about the repression of learning in Germany and the occupied countries, the dismissals of staff and their replacement, if at all, by political figures. One example of the effect of repression on scientific publications quoted by Dr. Needham is worth mention. Three scientific journals in his own field of work were, even before the War, one fifth or less of their former size ; one of these, the *Biochemische Zeitschrift*, decreased from 13 volumes in 1927 to 5 in 1938 and 2 in 1939, although the number of non-German contributors remained roughly the same. Science in Nazi Germany is valued solely in its relation to the needs of war.

British Electrical and Allied Industries Research Association

THE twenty-first annual report (Ref. E.R.A./*T*320) of the British Electrical and Allied Industries Research Association summarizes the work which has been carried out during the year ended September 30, 1941, and lists by titles the various research reports which have been issued during the period. The work is reviewed in seventeen major classifications among which are the highly important ones of dielectrics, cables and overhead lines, electric control apparatus, steam-power plant and condensers, magnetic materials, transformers, surge phenomena and rural electrification. Emphasis is laid upon the work which is still being carried out on circuit making and breaking, surge phenomena, and the properties of insulation, and attention is directed to the consideration now being given, for example, to the storage of electrical energy, the mechanical strength of transformer windings, and the quality improvement of electrical sheet steel. Practical circuit breaker design has been influenced considerably by the Association's investigations. In the insulating materials field, special account is being taken of the latest developments in plastics.

A new section with appropriate sub-committees has been set up to deal with problems of transformer engineering arising especially from war-time and post-war requirements. An exhaustive account has been published of seven years investigation for the Central Electricity Board on surge phenomena, and work has been carried out at the National Physical Laboratory on the surge properties of insulating materials and the surge resistance of tower footings. Researches on conductors, earthing, continuity and on electric control apparatus continue, and the hard gas circuit breaker is receiving special attention. The work of the Association on the application of electricity to agriculture and horticulture continues and is beginning to receive wider recognition in those circles.

The report discloses that the work of the Association is now carried on by no less than 109 technical sections, sub-committees and panels, comprised of experts engaged in industry and in universities and other training institutions. Eighty-three technical reports, relating to a wide variety of subjects, have been issued by the Association during the year, and thirty others were in an advanced stage of preparation at the end of the year. The Association has been recognized as an essential undertaking and a closer liaison has been developed during the year with the Ministry of Supply and, to a lesser degree, with the Fighting Services. The activities of the Information Bureau and Library have been increased by war-time requirements, and work on a complete analytical index to reports of the Association has been carried on during the year. The report is an encouraging survey of the researches which are being undertaken for the electrical industry to meet the needs, not only of war-time requirements, but also of the post-war reconstruction period. It is rightly considered that particular importance should be attached to reconstruction problems, which should receive adequate and timely attention from the point of view of research as new ideas, findings and methods must be absorbed by industry long before research results are needed in commercial enterprises.

Agricultural Meteorology in India

THE annual report of the Agricultural Meteorology Section, India Meteorological Department, for the year 1939–40 covers the last year during which the section was being financed by the Imperial Council of Agricultural Research, the Government of India having taken over the Section from April 1, 1940. The report describes a number of investigations, most of them concerned with the micro-climatology of crops, that is, with the climates experienced within growing crops, as distinct from the more artificial climate of the ordinary meteorological instrument enclosure which is of greater interest for comparisons between the climates of different countries. A number of new instruments have been developed, including several forms of portable but accurate galvanometer for use with thermocouples of copper and constantan for the measurement of temperature in micro-climatology. The recently completed 35-ft. tower at the Central Agricultural Meteorological Observatory at Poona has been found very useful for mounting thermographs, hygrometers and anemometers, for studies of the variations of temperature, humidity and wind with height, which are important in the control of the vertical exchange of heat and moisture between the soil and the overlying air. At Poona, insolation even in January is found to be so strong that the convective layer, with temperature decreasing with height, does not normally disappear during the night, and is generally still to be observed as a layer one or two feet thick at 6 a.m., when temperature in the lower layers is near its minimum. At that time it is generally coldest at a height of one or two feet, with temperature increasing upwards from that level for several hundred feet, the rise amounting already to about 3° C. on reaching the top of the 35-ft. tower. By April the greater insolation is more than counteracted in its tendency to maintain the convective layer by the effect of a higher average nocturnal wind speed, the net result being that the layer has almost disappeared by 6 a.m. The report includes a number of other studies relating to micro-climatology, among which is a table showing the average wind speed in the afternoon at various heights up to 8 ft. in eight different crops, expressed as a percentage of the wind at the same height above open ground. Up to 2 ft., wheat and sugar cane show the highest degree of sheltering, tobacco and suran the least.

Nobel Laureates in the United States

THE philanthropy of Alfred Nobel, the Swedish industrialist, is usually commemorated on December 10 in Stockholm or Oslo with the announcement of the new Nobel Prize winners. In its place a dinner was held in the United States on December 11 at which eleven Nobel laureates were guests of honour. The celebration marked the fortieth anniversary of the first awards. Nobel laureates who were present at the dinner included Dr. Viktor F. Hess, Dr. C. J. Davisson, Prof. Enrico Fermi, Prof. Otto Meyerhof, Dr. Karl Landsteiner, Dr. Irving Langmuir, Prof. H. C. Urey and Prof. Peter J. W. Debye. Dr. Vilhjalmur Stefansson presided.

Medical Research Council: Radiotherapeutic Research Unit

THE Medical Research Council announces that its Radiotherapeutic Research Unit (formerly Radium Beam Therapy Research) has now resumed clinical work in new quarters which have been provided by the London County Council at Hammersmith Hospital. For the present, this work will be confined to the treatment, by radium beam therapy or X-rays, of cases of carcinoma affecting the buccal cavity, tongue, pharynx and larynx. The director, Dr. Constance A. P. Wood, would be glad to have suitable cases referred to her: these should be patients who have had no previous treatment, either surgical or radiological, and preferably not in a very advanced stage of the disease. The physical work under the charge of Mr. L. G. Grimmett, which has meanwhile been continued in temporary quarters at the Imperial College of Science and Technology, has also been transferred to Hammersmith Hospital.

American Chemical Society: New President

DR. PER K. FROLICH, director of the Chemical Division of the Esso Laboratories of the Standard Oil Development Company at Elizabeth, N.J., known for his work in the development of synthetic rubber, has been elected president of the American Chemical Society for 1943. Dr. Frolich took office as president-elect on January 1, when Dr. Harry N. Holmes, head of the Department of Chemistry at Oberlin College, became president, succeeding Prof. William L. Evans, head of the Department of Chemistry at the Ohio State University. In addition to his contributions to the development of synthetic rubber, Dr. Frolich is best known for his work on transformation and chemical utilization of hydrocarbons, high-pressure gas reactions, catalysis and applied colloid chemistry. On September 9, 1940, he and his research associates read the first technical report on the discovery of butyl rubber, made from petroleum.

Dr. Frolich was born in Christiansand, Norway, in 1899, and graduated from the Norwegian Institute of Technology in 1921. He received the degree of master of science from the Massachusetts Institute of Technology in 1923, and the degree of doctor of science from the same institution in 1925. He was assistant chemist at the Norwegian Institute of Technology during 1919–1921, instructor at Christiansand Business College during 1921–1922, and American-Scandinavian Foundation fellow at the Massachusetts Institute of Technology during 1922–1923. He served as assistant in the Massachusetts Institute of Technology Research Laboratory of Applied Chemistry during 1925–1927. He became assistant director of the Laboratory in 1927 and was advanced to associate professor in 1929, the year he joined the staff of the Standard Oil Development Company. He was awarded the Grasselli Medal in 1930 for outstanding achievement in chemistry, particularly in the field of high-pressure reaction of gases.

Centenary of Flammarion

CAMILLE FLAMMARION, the French astronomer whose books found readers in all parts of the globe, was born on February 25, 1842, at the small town of Montigny-le-Roi, in Haute-Marne. The son of a shopkeeper, he was educated at a church school and then began work in an engraver's office. His merits being brought to the notice of Leverrier, at the age of sixteen he was given a place in the Paris Observatory, where he stayed four years. At the age of twenty he published his first book, "The Plurality of Inhabited Worlds", the forerunner of his "The Marvels of the Heavens", "Popular Astronomy", "The Planet Mars", "Astronomy for Amateurs" and many others. His "Popular Astronomy" when first published in French in 1879 was awarded the Montyon Prize of the Paris Academy of Sciences and was selected for use in the French public libraries. Through an admirer of his writings, Flammarion, in 1883, came into possession of a small château and park at Juvisy-sur-Orge and he built an observatory there. The previous year he had founded the review, *L'Astronomie*, and five years after that, in 1887, he started the Société Astronomique de France. His death took place at Juvisv, June 4, 1925, when he had reached the age of eighty-four.

University of Sheffield

THE University of Sheffield has received a bequest of £1,200 by the late Mr. L. N. Ledingham to found a bursary fund for students in the Department of Metallurgy, to be called "The Ledingham Bursary Fund".

The Council decided that because of the close association of the Department of Pharmacology with clinical teaching and because the professor of pharmacology is responsible for the teaching of therapeutics, the Department of Pharmacology should in future be given the title of Department of Pharmacology and Therapeutics, and that the professor of pharmacology should be given the title of professor of pharmacology and therapeutics.

Announcements

DR. R. L. WATERFIELD has been awarded the Jackson-Gwilt Medal and Gift of the Royal Astronomical Society "for his general contributions to astronomy, and in particular for his photographic work on eclipses and comets and his visual observations of planets". The Medal will be presented at the annual general meeting to be held on April 10.

THE King has approved the following awards of the Polar Medal in silver for good services with the Oxford University Arctic Expedition to North East Land in 1935 and 1936: Lieut. A. R. Glen; Instr. Lieut. R. Moss; A/Major N. A. C. Croft; Major A. S. T. Godfrey; Capt. A. B. Whatman; R. A. Hamilton, D. B. Keith, A. Dunlop-Mackenzie, J. W. Wright.

THE Edison Medal for 1941 has been awarded by the American Institute of Electrical Engineers to Prof. J. B. Whitehead, director of the school of engineering of the Johns Hopkins University, "for his contributions to the field of electrical engineering, his pioneering and development in the field of dielectric research, and his achievements in the advancement of engineering education".

THE Committee of the Athenæum has elected the following gentlemen, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, or the arts, or for their public services: Air Chief Marshal Sir Wilfrid Rhodes Freeman, Vice-Chief of the Air Staff; Prof. E. H. Minns, emeritus professor of archæology, University of Cambridge; Prof. P. H. Winfield, Rouse Ball professor of English law, University of Cambridge.

DR. H. SPENCER JONES, Astronomer Royal, will deliver the Symons Memorial Lecture of the Royal Meteorological Society on March 18. He will speak on "The Atmosphere of the Planets".

The following appointments in the Colonial Service have recently been made: Mr. J. C. Alley, veterinary officer, Nigeria; Captain L. Nicholls (conservator of forests), deputy chief conservator of forests, Nigeria.

WE have received a copy of the 1941 edition of the Official Directory of the British Chemical Plant Manufacturers' Association, containing a directory of members, a classified list of products and services, a list of proprietary and trade names and marks, and other information. A copy of this Directory will be issued gratis to inquirers interested in the purchase of British chemical plant on application to the Association, 166 Piccadilly, London, W.1.

ERRATUM. In the article "Feeding Post-War Europe", by Dr. Geoffrey Bourne, NATURE, February 14, p. 182, the amount of vitamin C required by Great Britain should read "700 tons" and not "30 tons" as printed.

WE regret that it has not yet been possible to issue the Index to vol. 148 of NATURE. An announcement will be made as soon as the date of publication is fixed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

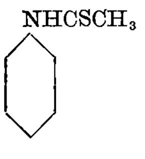
Hydrogen Bonds Involving the Sulphur Atom

The view is very generally expressed[1] that sulphur does not take part in hydrogen-bond formation. This conclusion is based mainly on the normal physical properties of hydrogen sulphide, as compared with water, and on the absence of molecular association in thioalcohols and thiophenols. Such evidence is obviously only valid against the S-H-S bond.

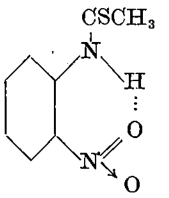
On the contrary, there are various indications that the sulphur atom can form hydrogen bonds of the type S-H-O and S-H-N possessing considerable stability. For example, quinhydrone-like complexes between quinones and thiophenols or mercaptans have long been known; their existence is probably due to S-H-O bonds. Again, the tautomerism of the thio-acids, $R.COSH \rightleftharpoons R.CSOH$, is probably attributable to their associated (hydrogen bond) structure. Contemporary American workers have recently attributed the anomalous behaviour of mercaptans in certain donor solvents in regard to heats of mixing[2], and infra-red absorption[3], to the formation of weak S-H-N and S-H-O bonds.

Recent work[4] from this laboratory has indicated that a factor which contributes more than any other to hydrogen-bond stability is the condition that the hydrogen atom constituting the bond should be tautomeric. We have, therefore, sought evidence of hydrogen-bond formation in the thioamides and the thioanilides, the tautomeric behaviour of which is formally represented by the equilibrium $R.CSNHR' \rightleftharpoons R.C(SH):NR'$. Cryoscopic measurement of molecular weight of a large number of thioamides in naphthalene solution has shown that those which possess an unsubstituted imino-hydrogen atom (as in $R.CSNH_2$ and $R.CSNHR'$) exhibit marked molecular association, whereas those in which both imino-hydrogen atoms have been replaced (for example, $R.CSNRR'$) are invariably unimolecular. It would appear, then, that the association of the former type is due to intermolecular S-H-N bonds.

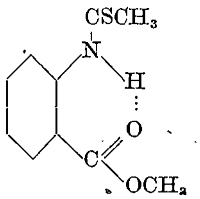
Further evidence of the hydrogen-bond structure of the thioamides is provided by the behaviour of nuclear-substituted derivatives of thioacetanilide (I). We find that the considerable molecular association shown by this compound[5] is completely checked by the substitution of suitable *o*-substituents capable of chelating with the anilido-hydrogen atom. Evidently, the hydrogen atom thus engaged is incapable of further union with the sulphur atom of a second molecule. Thus, *o*-nitro- (II) and *o*-carbmethoxy-thioacetanilide (III) are substantially unimolecular.



(I)



(II)



(III)

A parallel investigation of the molecular condition of the thioacids has confirmed that they also are associated (originally observed in the single case of thioacetic acid by Auwers[5]), whereas their esters ($R.COSR'$) are not. Evidently the association of the thioacids is due to intermolecular S-H-O bonds.

A more complete account of this work will be published elsewhere.

T. G. Heafield.
G. Hopkins.
L. Hunter.

Chemical Department,
University College,
Leicester.
Jan. 23.

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[1] See, *inter alia*, Sidgwick, "The Covalent Link" (Cornell, 1933), p. 164. Lassettre, *Chem. Rev.*, 20, 267 (1937); Pauling, "The Nature of the Chemical Bond" (Cornell, 1940), p. 290.

[2] Copley, Marvel, and Ginsberg, *J. Amer. Chem. Soc.*, 61, 3161 (1939).

[3] Gordy and Stanford, *J. Amer. Chem. Soc.*, 62, 497 (1940).

[4] Hunter *et al.*, "The Associating Effect of the Hydrogen Atom, Parts I–IX", *J. Chem. Soc.* (1937–1941).

[5] Auwers, *Z. phys. Chem.*, 30, 529 (1899).

Quantum Efficiency of Photosynthesis

It is generally accepted that about four energy quanta of red light ($\lambda = 660\ \mu\mu$) are needed to promote the assimilation of one molecule of carbon dioxide. This conclusion is based in the main on the measurements of Warburg and Negelein[1], who determined the ratio W/E, that is, the volume of carbon dioxide assimilated by Chlorella during the absorption of one calorie of light energy. They designated this ratio by φ and, since it is well known that φ increases with decrease in light intensity, the value φ_0 found with the minimum intensity was adopted.

As the mean of nine measurements it was found that 116·8 c.mm. of carbon dioxide were assimilated during the absorption of one calorie of red light energy. It follows from this that 191,781 calories would be absorbed during the assimilation of one gram mole of carbon dioxide and, since the value of $Nh\nu$ at $\lambda = 660\ \mu\mu$ is 43,112 calories, that 4·45 energy quanta were absorbed for each molecule of carbon dioxide assimilated. In a similar series of measurements with blue light ($\lambda = 436\ \mu\mu$) it was found 5·1 energy quanta were absorbed for each molecule of carbon dioxide assimilated.

Now these and any similar determinations of the quantum efficiency of photosynthesis are based on the assumption that the whole of the light energy absorbed is utilized in promoting the assimilation of carbon dioxide. Expressed in other words, this assumption means that the absorption of light energy by Chlorella is entirely caused by the photo-assimilation which takes place. If this were correct, a suspension of Chlorella in which photo-assimilation has been inhibited by hydrogen cyanide would not absorb red or blue light and hence would be almost colourless.

Furthermore, Warburg[2] proved that, when the light intensity and temperature are maintained constant, the number of molecules of carbon dioxide assimilated in unit time by Chlorella increases at first very rapidly and then more slowly as the external concentration of carbon dioxide is increased from 1×10^{-6} to 90×10^{-6} gram mole per litre. On the assumption made by Warburg and Negelein, this indicates that the number of energy quanta needed to promote the assimilation of one molecule of carbon dioxide decreases with increase in the external concentration of carbon dioxide.

Then again it is well known that the leaves of plants exhibit fluorescence during photo-assimilation and Kautsky and Hirsch[3] proved that the intensity of this fluorescence is much less with strongly assimilating leaves than under normal conditions. This radiation of light energy during photo-assimilation proves that the whole of the light energy absorbed is not utilized in promoting assimilation.

It thus becomes manifest that the assumption that the whole of the light energy absorbed is utilized in promoting photo-assimilation cannot be justified. Warburg and Negelein's calculations of the quantum efficiency would, therefore, appear to be invalid.

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[1] *Z. phys. Chem.*, **106**, 191 (1923).

[2] *Biochem. Z.*, **100**, 258 (1919).

[3] *Naturwiss.*, **19**, 964 (1931).

Waves and Tidal Streams

IT has been shown[1] that the steepness of secondary waves riding on primary ones ranges from $s(1-\pi S)^{-2}$ to $s(1+\pi S)^{-2}$, at crest and trough of primary, S and s being primary and secondary steepness. The special case in which the tidal wave is the primary, and the larger wind-formed waves are the secondaries, is of some interest. As S is then almost nil, s does not vary. This means that the steepness of wind-formed waves is unaffected by the mere turn or making of the tidal stream. So some further explanation must be sought for the great change in the state of the sea when the stream turns to the weather, a change too great to be accounted for by the increase in speed of wind over water, and one which ordinarily takes place even after the wind has dropped, as will be assumed here.

Change in direction or strength of stream will not change the steepness of the waves if they are travelling through an area of uniform tidal strength—uniform maximum strength. It is different when the (maximum) strength varies as between one position and another. Then maintenance of the sequence of the waves constituting the swell involves the crests opening out or closing up according to the change in stream, the closing up of sailing vessels as they run into a calm patch, or of road traffic which has to climb a steep hill, being analogous examples. The reduction in length when waves meet a foul stream of greater strength entails reduction in their speed, and in the speed of their energy through the water, with greater percentage reduction in the speed of the energy over the ground. Then continuity of the supply causes the energy to crowd up, and the greater number of units of energy squeezed into each square foot of water surface entails increase in wave height. Thus wave-length is reduced, and wave-height increased, and the sea steepens.

It will suffice to take the case in which waves run from a deep slack-water area into one in which the depth is D and speed of stream C, for the final result will be the same whether they pass directly from depth D_1 and stream C_1 into depth D_2 and stream C_2, or do so through intermediate deep slack water. Let L_0, T_g, V_0, G_0 be length, period and speeds of waves and energy in deep slack water, and L, V, G_w, G_g be length, wave speed through water, and speeds of energy through water and over ground, where the depth is D and the stream has speed C, C being negative when weather going or foul. T_g will also apply to the second area, if observed from the shore. Owing to continuity of sequence :

$$T_g = \frac{L_0}{V_0} = \frac{L}{V+C}.$$

It follows that

$$\frac{V}{V_0} = \tfrac{1}{2}\tanh\frac{2\pi D}{L}\left\{1 \pm \sqrt{1 + \frac{4C}{V_0}\coth\frac{2\pi D}{L}}\right\};$$

or, for deep water,

$$\frac{V}{V_0} = \tfrac{1}{2}\left\{1 \pm \sqrt{1 + \frac{4C}{V_0}}\right\}$$

Where $C = -\tfrac{1}{4}V_0$ in deep water, $G_g = 0$, and the waves must break, however small their initial steepness. This leads to the rather unexpected result that waves with slack water lengths of 100 and 400 ft. cannot stem streams stronger than 3½ and 6¾ knots. With appreciable initial steepness they will break at earlier stages, but may survive after some of their energy has been dissipated into heat. Thus in a tide race, or on a bar, there may be more or less standing lines of breakers, even without sudden change in depth. To leeward of the position where $C = -\tfrac{1}{4}V_0$, the sea will be calm.

When D/L is small, the plus sign only operates until $C = -\tfrac{1}{4}V_0$. Then the minus sign comes into play, and holds good until $G_g = 0$. But its reign will be a short one, for analysis shows that unless D is less than $L_0 \div 20$, the minus sign only starts to function when C is within 5 per cent of the strength necessary to reduce G_g to zero.

As $G_w = V - L\frac{dV}{dL}$, $L\frac{dC}{dL} = G_g$: and so, when G_g has become small, the waves only retain a small margin of stability, and the sea will be confused.

For present purposes, stream athwart the direction of wave travel may be ignored, and the water regarded as slack. So onshore waves may be taken as passing from slack water into stream, fair or foul, as they enter an estuary. Those which enter late on the ebb will steepen, and in so far as the estuary is of uniform tidal strength, their steepness will be unaffected by the turn of the stream. But later waves, entering on the early flood, will lengthen, so that their energy will travel faster through the water, and tend to catch up that of the earlier batch. This may account for what would otherwise seem a rather astonishing statement on the part of some Bristol Channel pilots—that the worst seas off the Foreland occur towards the end of the flood. The Bristol Channel is almost long enough for overtaking to take place, so that the two lots of energy tend to become superimposed.

When the earlier batch of energy, intensified by entrance on the ebb, passes a bay in the shore of the estuary after the flood has made, the drainage from its main stream due to its spreading out laterally into the bay will be rapidly made good, owing to its increased speed over the ground. Thus the supply is maintained, and there will be a heavy roll in the bay during the flood, a common occurrence.

Lastly, as the length of swell is unaffected by the mere turn of the stream, observation of period, made from the shore of an estuary, may not necessarily give an accurate indication of wave-length in the open.

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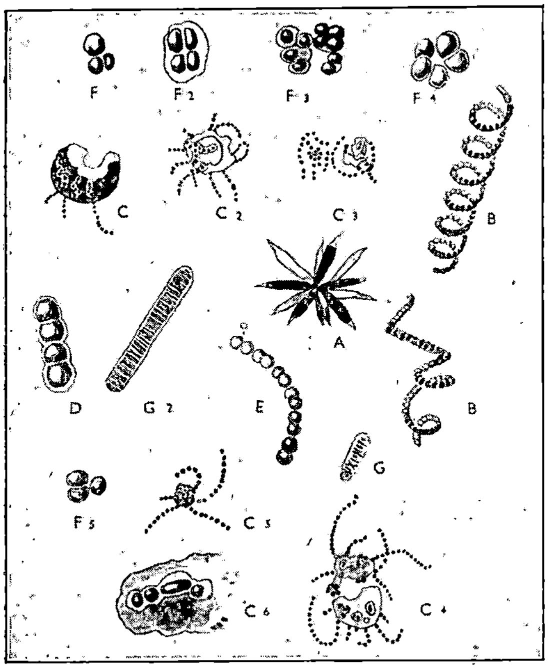
[1] Nature, **148**, 226 (1941).

Normal Rumen Microflora and Microfauna of Cattle

The elucidation of the factors concerned in the digestive assimilation by cattle of starch, cellulose, and also of protein substitutes, necessitates an accurate knowledge of the functional activities of the rumen micro-organisms. On this subject very conflicting opinions have been advanced[1,2,3] based in many cases upon the results of inoculation of rumen-contents into artificial media. The value of these results, moreover, must always remain uncertain[4,2] until the characteristics of the normal rumen microflora and microfauna have been independently determined by direct microscopical observation. Appropriate methods have been applied by me to the investigation of the gastro-intestinal contents of various herbivora[4,5,6,7,8].



Iodophile microflora of cattle.

A, rosette association of unidentified organisms; *B*, giant spirillum; *C*–*C*$_5$, stages in disintegration of starch grains by coccoids; *C*$_6$, surface of grain showing lacunæ surrounding coccoids; *D*, coccoid chains (giant form); *E*, coccoid chains (normal type); *F*–*F*$_5$, sarcina packets; *G*, *G*$_2$, *Oscillospira guillermondi*.

With the assistance of a grant from Imperial Chemical Industries, Ltd., these studies were extended in order to afford a microbiological control to *in vitro* incubations of rumen contents in progress at the Hannah Dairy Research Institute[9]. Observations were made upon local (Guildford) slaughter-house material as well as upon fistula samples submitted by the Institute. Fresh and formalized material was examined. The very numerous samples investigated made it possible to construct a representative picture of the normal rumen microflora and microfauna. This always includes:

(*a*) Protozoa of the families Ophryoscolecidæ and Isotrichidæ. These have been described and monographed by numerous investigators[10,11].

(*b*) An iodophile microflora, that is, an association of taxonomically diverse species exhibiting, in consequence of the presence in them of 'bacterial starch' or granulose, the common characteristic of giving a blue reaction with iodine. Such organisms have hitherto received scant attention from the majority of investigators, though they are found in all domestic Herbivora[12]. At least five species easily distinguished by their large size ('giant' forms) and characteristic morphology were invariably encountered, namely:

(1) *Oscillospira guillermondi*, Chaton and Perard[13] (Oscillaria caviæ, Simons[14]). A colourless spore-forming oscillarian (5–20 × 3–4 μ).

(2) *A giant spirillum* (15–40 × 1–2 μ) divided internally by transverse septa into spherical or ovoid compartments.

(3) *Large Sarcina packets* (1·5–3 μ).

(4) *An unidentified navicular organism* (bacterium) forming rosette-shaped associations of 5–30 units (4–8 × 0·9–1·5 μ).

(5) *Coccoid chains* of 2–8 units (*a*) (4–10 × 1·5–2 μ). (*b*) (*Smaller variant* 15 × 1·2–1·5 μ).

By the use of the polarizing microscope and histochemical methods[1,13], it was demonstrated that certain iodophile micro-organisms play a determinant role in the decomposition both of starch and cellulose. These results confirm those established by me for other Herbivora[2,4].

The functional activities of the rumen micro-organisms can be still further elucidated by *in vitro* incubations of rumen contents. In such experiments the maintenance of the iodophile microflora and protozoan microfauna clearly establishes the preservation of normality over the period of incubation. During this period, therefore, the results of biochemical and micro-biological analysis may reasonably be assumed to give a true representation of processes occurring in the living animal. By the use of counting methods the influence of chemical and physical factors upon the growth-rate of the iodophile micro-organisms could be ascertained. Thus a qualitative and quantitative control of the conditions established *in vitro* was secured.

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[1] Krebs, K., *Zent. Agriculturchemie*, (B), **9**, 394 (1937).

[2] Mangold, E., "Handbuch der Ernährung, etc., der landwirtschaftlichen Nutztiere" (Berlin, 1929).

[3] Pochon, J., "Rôle d'une bactérie cellulolytique de la panse" (Laval, 1935).

[4] Baker, F., *Sci. Prog.*, No. 134 (Oct. 1939).

[5] Baker, F., *Zent. Bakt.*, Ab. II, **88**, 17 (1933).

[6] Baker, F., and Martin, R., *Zent. Bakt.*, Ab. II, **96**, 18 (1937).

[7] Baker, F., and Martin, R., *Zent. Bakt.*, Ab. II, **97**, 201 (1937).

[8] Baker, F., and Martin, R., *Zent. Bakt.*, Ab. II, **99**, 400 (1939).

[9] Owen, K., Smith, J. A. B., and Wright, N. C., Nature, **147**, 710 (1941).

[10] Doflein, F., "Lehrbuch der Protozoenkunde", 5te Aufl. (Jena, 1928).

[11] Wenyon, "Protozoology", Vol. 2 (London, 1926).

[12] Baker, F., and Martin, R., Nature, **141**, 877 (1938).

[13] Chaton, E., and Perard, C., *C.R., Soc. de Biol.*, **74** (1913).

[14] Simons, H., *Zent. Bakt.*, Ab. II, **50** (1920).

Afferent Innervation of Mammalian Abdominal Viscera

THE afferent nervous pathways from abdominal viscera have been studied by McSwiney and his co-workers by means of the changes in pupil diameter induced by stimuli such as weak faradic shocks applied to the central end of the cut splanchnic nerve (Bain *et al.*[1]), or to the central end of the cut abdominal vagus nerve (Harper *et al.*[2]). Investigations, by oscillographic methods, of the afferent nervous activity in the frog's viscera have been carried out by Tower[3], and later confirmed by Burns[4]. It was shown that the gut and mesentery gave rise to fast nerve impulses in the sympathetic rami in response to light touch. These impulses are not dissimilar to those in cutaneous sensory nerves in response to light touch on the frog's skin. On examining the afferent nervous mechanism in visceral nerves of the cat and rabbit, it has now been shown that a somewhat similar mechanism sensitive to light touch is present. Thus in response to light touch on the gut or the mesentery, trains of impulses of a fast type can be shown to ascend in the small nerve trunks which run, in company with blood vessels, across the mesentery from its intestinal attachment towards the mesenteric root. The exact distribution of this tactile sensibility and the function of the cat's mesenteric Paccinian corpuscles are being investigated.

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[1] Bain, W. A., Irving, J. T., and McSwiney, B. A., *J. Physiol.*, **84**, 323 (1935).

[2] Harper, A. A., McSwiney, B. A., and Suffolk, S. F., *J. Physiol.*, **85**, 267 (1935).

[3] Tower, S. S., *J. Physiol.*, **78**, 225 (1933).

[4] Burns, W., *J. Physiol.*, **100**, 11P (1941).

Biology and War

IN these days when both comfort and efficiency are so dependent upon science and its applications, it is surely astonishing that so little weight is attached to the teachings of biological—apart from medical and agricultural—science in relation to problems which in these days have urgent importance.

An impressive example is afforded by the continued misuse of paint or pigment in relation to camouflage although the main principles of this were worked out more than a quarter of a century ago. Another is seen in the development of aircraft with refusal to grasp the fact that Nature had provided in the bodies of rapidly swimming fish a ready-made demonstration of the streamlined form most effective for rapid movement, whether through a denser medium such as water or a more tenuous one such as air. It is only now, after much needless expenditure of time and money, that the fuselage of fighter aircraft is seen to attain the correct form indicated by Nature.

Still another is concerned with the varying power of 'light' of different wave-lengths, as regards, on one hand, visibility by the human eye and, on the other, power of penetrating the atmosphere. A walk along a straight road on a hazy winter evening is enough to show by the reddening of the lamps with increasing distance the greater penetrating power of rays towards the red end of the spectrum. A walk by day when the sky is clear but the ground enveloped in thick haze shows a complete absence of the sharp shadows of sunlight; and yet the photographer armed with films sensitive to infra-red rays sees these shadows sharply depicted in his photographs, the infra-red rays finding their way past the water particles suspended in the atmosphere until these become big enough to form wet fog or rain. Yet no steps are taken to compel all ships of considerable size to be equipped with the necessary apparatus—photographic or fluorescent—to see through haze dense enough to conceal dangers to navigation though fine enough in the size of its water particles to allow the passage of the infra-red rays.

Blindness to such simple examples is necessarily accompanied by blindness to more elusive teachings of biology. Perhaps the most striking feature in the evolution of animal organisms is their advancement in size from small microbes to the relatively large creatures familiar in the animal world of to-day. This onward progress is a normal feature of evolution. It brings with it increased efficiency, increased power, increased speed of movement. But it also brings with it the seeds of decay and death. The geological record of evolution is littered with the remains of great powerful creatures which have become extinct while their smaller, feebler contemporaries have survived. The increase in size has in fact been attainable only by a corresponding increase in complexity of organization, involving the development of an ever greater multiplicity of parts, an ever greater sensitiveness to impressions from without, an ever greater centralization of control both over normal activities and over the appropriate reactions to emergencies. All this brings with it serious danger: vital processes are apt to become clogged and slowed down; destruction may come to the whole through the failure of some small part.

Blindness to such biological facts finds expression in many of our troubles of to-day. The air is full of complaints regarding the slowness of Government departments to act or to react—slowness which at times may have disastrous consequences. It is unfair in such cases to concentrate all the blame upon particular officials. It should rather be realized that many departmental shortcomings are inevitable results of their growth in size; and the only sure way to get rid of them is to diminish the potency of the size factor by a reversal of the normal evolutionary development. In some cases this can be effected by the resolution of the overgrown department into a number of more or less independent smaller ones. In others where this is not practicable, much can be done by the free delegation of authority by the central government to local bodies familiar with local conditions and free to take action on their own responsibility. The obvious dislike of the central departments to delegate any of their authority, to give up any of their powers of control, seems sometimes to imply a cynical disbelief in the reasonableness, or indeed the honesty, of the average citizen—a view which if it exists is most undoubtedly wrong.

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RESEARCH ITEMS

Early Man in New Mexico

An interesting excavation has been undertaken by F. C. Hibben, of the University of New Mexico, at Sandia and other cave sites in the Sandia-Manzano region of New Mexico. A stratigraphical sequence of deposits was obtained, there having been six levels in all, three of which contained archæological remains separated by sterile layers (Smithsonian Miscellaneous Collections, 99, No. 23). The uppermost level yielded pottery of early Spanish or immediately pre-Spanish date, the second one produced a Folsom industry, while from the lowest archæological bed there was unearthed a new pre-Folsom industry to which has been given the name of the site—Sandia. This industry, judging from the descriptions and photographs, would seem to be related to that of the middle, Folsom, level, but must be considered more primitive. Its typical tool is a sort of shouldered laurel leaf. At the bottom of this Sandia level the standard of flaking was not too good, very different indeed from the beautiful technique used by the makers of the true Folsom points. "Basal thinning" and "facial channels" are absent; the edges of the bases are smooth. The Sandia points from the upper part of the level, however, are far better made, being elongated with parallel sides and straight or somewhat indented butts. As before, the points are shouldered, doubtless for hafting purposes. A few scrapers were found, but the Sandia level as a whole was not rich in types. Such a clearly stratified pre-Folsom industry as this is obviously a matter of great interest. In an appendix to Hibben's paper, Kirk Bryan of Harvard University has attempted to demonstrate a high antiquity for the Folsom and Sandia levels at this site. He bases his theory on a study of the deposits themselves, which leads him to the conclusion that the Folsom layer is to be equated with our Pomeranian (late quaternary) glacial stage (= Mankato continental ice of North America), while the Sandia level is, of course, even older. This problem of the antiquity of man in the Americas is always cropping up, and it will be interesting to see whether Kirk Bryan carries his colleagues with him in assigning such a great age to these industries.

Elasticity of Bovine Cervical Mucus

An interesting adaptation of the measurement of a physical property to the study of a biological process is given by Scott Blair and others (*Biochem. J.*, 35, 1039; 1941). Determination of nitrogen and solid content, viscosity and flow elasticity have been made on bovine cervical mucus during the œstrous cycle. Flow elasticity shows a marked maximum at œstrus, and a simple apparatus, the 'œstroscope', for the measurement in the cowshed is described. It is believed that the œstroscope technique should be of practical value to stock breeders, especially for prediction of œstrus in cases where it is liable to be missed and for its diagnosis in cases where ovulation is unaccompanied by external signs of heat (see also Nature, 147, 453; 1941).

Lecithinase Activity of *Cl. welchii* Toxins

Knowledge of the chemical nature of the specific toxins from toxic culture filtrates would be advantageous in preparing antitoxic sera and in studying the mode of action of the toxins on the cell. Because of the importance of *Cl. welchii* in war-wound infections, M. G. Macfarlane and B. C. J. G. Knight (*Biochem. J.*, 35, 884; 1941) decided to investigate the enzymic activity of toxic culture filtrates of this organism. It has been known that the activity of the toxin in producing an opalescence in human serum or egg yolk is a measure of α-toxin content. The authors now show that the specific α-toxin, the lethal hæmolytic and necrotic factor, is probably identical with a lecithinase (optimum *p*H 7·0–7·6) activated by Ca^{++}, which decomposes lecithin into phosphocholine and a diglyceride. It is probable that this lecithinase would confer hæmolytic and necrotic powers on the toxin, since it would have a disintegrating effect on any cell membrane or intracellular lipoprotein complex the integrity of which depended on the presence of lecithin. The anti-lecithinase activity of *Cl. welchii* (type *A*) antitoxic sera runs parallel with the animal protection titre and is a fair measure of the α-antitoxin.

Problems of Bee Keeping

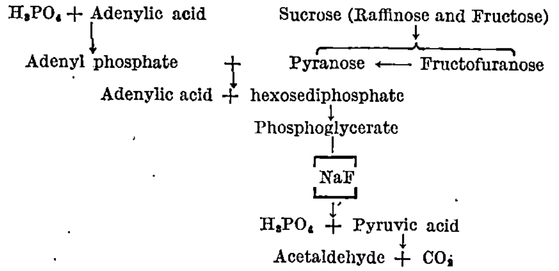
It is learned from the *Bee World* of January, 1942, that some important advances in knowledge of bee diseases have emanated from the Liebefeld Research Institute. It appears that Hans Schneider has found that a form of the mite Acarapis, which frequents the wings and first abdominal segment, is distinct from those previously known. The provisional name of *A. vagans* has been given (*Mitt. Schw. Entom. Ges.*, 18, 6; 1941). This mite is stated to occur only in quantity in stocks badly infected with Nosema. Prof. R. Burri, until 1937 director of the Institute named above, has made a notable advance in knowledge regarding European foul brood. He claims that the organism concerned, namely, *Bacillus pluton*, has been cultivated for the first time in an artificial medium. This discovery if substantiated is one of great value since there has always been room for doubt whether *B. pluton* is the actual causative agent of European foul brood disease because it could never be cultivated outside the bee larva. So far no particulars have been published regarding the nature of the culture medium employed. A third item referred to in the *Bee World* concerns the Frow remedy for acarine disease. It appears that V. Peterka and J. Svoboda have found that nitrobenzene is the ingredient in the Frow treatment that is lethal to the mites concerned. They also find that safrol oil does not kill the mites and is the substance responsible for injuring the bees. They therefore substituted methyl salicylate for safrol oil and found that the treatment thus modified is preferable to the original remedy.

Inheritance in the Grasshopper

M. Creighton and W. R. B. Robertson (*J. Hered.*, 32, 339) have studied the inheritance of several colour patterns of *Chorthippus longicornis* of Iowa which may correspond with *C. parallelus* of Britain. Their results show that there is a multiple allelomorph series which controls colour on the sides and back. The most commonly found colour form—'plus' type—is the most recessive form. Interesting comparisons are made between the life-histories of *C. longicornis* in Iowa and *C. parallelus* as studied by Sansome and La Cour (*J. Gen.*, 30, 415; 1935). The colour forms are different, while the number of eggs per pod, the time of development of the insect and the development of elytra are dissimilar.

Respiration in Barley

In two further contributions by James and his co-workers to our knowledge of the respiratory system in barley (James and Bunting, *New Phyt.*, 40, 268; 1941; Bunting and James, *New Phyt.*, 40, 262; 1941) the carboxylase activity of barley powders and expressed saps is further examined and its presence confirmed. From the fact that a mixture of the sap and the powder obtained from the residue after sap expression is greater than the sum of their separate activities it is further concluded that the carboxylase system includes an insoluble apoenzyme and a soluble coenzyme. A typical clear barley sap gave a positive fluorescence test for cocarboxylase and it is estimated that 100 gm. of barley tissue contains about 30 γ (as diphosphothiamine) of this substance. In the second paper, respiration in barley is shown to follow much the same course as in yeast. Adenylic acid added to barley saps containing sugar and free phosphate give an increased CO_2 production as compared with untreated controls. The addition of hexosediphosphate and of phosphoglycerate to the digests increases the carbon dioxide output to about the same extent, and the effect of the former is completely inhibited by *M*/40 sodium fluoride. Since the enzymatic conversion of phosphoglycerate to pyruvic acid is exceptionally sensitive to this poison, it is concluded that phosphoglycerate follows hexosephosphate in the chain of respiratory reactions. From this and previous work, respiration in barley is represented along the following expanded scheme:


H_3PO_4 + Adenylic acid
Adenyl phosphate
Adenylic acid + hexosediphosphate
Sucrose (Raffinose and Fructose)
Pyranose ⟵ Fructofuranose
Phosphoglycerate
NaF
H_3PO_4 + Pyruvic acid
Acetaldehyde + CO_2

Kalsilite-bearing Volcanic Rocks in Uganda

At the Mineralogical Society on January 22, A. Holmes described a suite of volcanic rocks from south-west Uganda containing the new mineral kalsilite, a hitherto unrecognized polymorph of $KAlSiO_4$. The leading volcanic types of the Bunyaruguru field are distinguished by the following pairs of the four critical minerals: augite, melilite, leucite and kalsilite.

Ugandite	=	Augite + leucite	With abundant olivine, perovskite and black ore ± glass.
Mafurite	=	Augite + kalsilite	
Katungite	=	Melilite + leucite or leucitic glass	
Kalsilite-katungite	=	Melilite + kalsilite	

For the new rock-type characterized by the association augite-kalsilite the name mafurite is proposed. A heteromorphic variety with abundant biotite is distinguished as biotite-mafurite. Varieties transitional to ugandite are described as leucite-mafurite and kalsilite-ugandite. Melilite-mafurite, transitional to katungite, also occurs. Six new chemical analyses are presented. F. A. Bannister and M. H. Hey have investigated the new mineral by X-ray and microchemical methods respectively. The grains of kalsilite yield a hexagonal Laue pattern which is much simpler than those of nepheline and kaliophilite. The refractive indexes of kalsilite are $\omega = 1{\cdot}542$; $1{\cdot}537$; and it is thus not possible to distinguish kalsilite from nepheline in thin section.

Environmental Factor in Corrosion

According to V. J. Albano (*Bell Lab. Rec.*, 20, No. 3, Nov. 1941) corrosion results from the natural tendency of ordinary metals to revert to stability by combination with the surrounding elements, variation in the chemical properties of which, however, may be such that a metal which is resistant to corrosion in one way becomes attacked quickly in another. In Nature, sufficient traces of moisture and dissolved chemicals are usually present to render the environment active, but under certain conditions protective films form on many metals. Film formation requires an environmental substance that reacts with the metal to form an insoluble, impervious and adherent surface compound. The presence of corrosive substances militates against the formation of such a film. Distilled water lacking film-forming substances corrodes lead very easily, whereas city tap-water covers the lead with an inert and invisible protective film. Environment also governs galvanic corrosion between dissimilar metals, corrosion being accelerated by electrochemical action, seriously so in industrial and marine atmospheres, in soils and in waters. The more direct way to mitigate corrosion is to remove the corrosive constituents in the environment. The removal of dust and sulphur gases from air and the addition of film-forming ions, such as silicates, chromates and phosphates to water, or the removal of activating materials like chlorides, nitrates, and dissolved oxygen are all aids to the mitigation of corrosion. The indiscriminate selection of a metal for service in a specific environment based on its corrosion behaviour elsewhere is both unsatisfactory and uneconomical.

Great Sunspot of September 1941

In the December issue of *Observatory* (64, 161; 1941) H. W. Newton describes the sunspot group which crossed the sun's disk between September 10 and 23, 1941. At maximum, on September 18, the group had an area of about 2,500 millionths of the hemisphere, which ranks it among the 'great' spots. A short-wave radio fade-out beginning at 0830 U.T. on September 17 was evidently associated with a brilliant chromospheric eruption first observed, close to the leading spot, at 0838, and with a characteristic kick on the Abinger magnetic traces at 0821. About 20 hours later an intense magnetic storm began, the major disturbances lasting for more than 24 hours. The total ranges in the magnetic elements during the period were 2° 3′ in declination, 1,252 γ in horizontal intensity, and 1,116 γ in vertical intensity. This range in *V* is bigger than that produced by any other magnetic storm of the present solar cycle. Auroral displays in unusually low latitudes were observed on the morning of September 18 and the evenings of September 18 and 19. The sequence of events here is similar to that of the magnetic storms of March 1 and July 14, 1941, namely, a brilliant chromospheric eruption, accompanied by a synchronous radio fade-out and a small magnetic disturbance, is followed after a day or so by a great magnetic storm and associated auroræ. The eruption is usually associated with a sunspot, though not necessarily with a large one, hence the looseness of the correlation of magnetic storms with great spots. The information accumulated during and since the last sunspot maximum points to the significance of chromospheric eruptions in causing not only the radio fade-outs which occur simultaneously, but also the magnetic storms which follow after a time lag of about 20 hours.

EVOLUTION IN THE PETROLEUM INDUSTRY

IN a paper on the above subject read before the Royal Society of Arts on January 21, Mr. James Kewley did not restrict the term 'evolution' to its purely biological sense of adaptation of species of organisms to changing conditions of environment. Rather he gave to it an added significance and power to embrace not only spontaneous changes, but equally predetermined policies designed by man to meet, or even anticipate, commercial and economic demands. Thereafter he proceeded to determine the measure of success achieved within the industry by citation of facts which by their very baldness proclaim the power of such man-made evolution.

In 1895 the deepest well drilled was 1,200 ft. Then came the cry for greater production of crude oil. To meet this, deeper and deeper wells were drilled until in 1940 the record was held by one sunk to a depth of 15,000 ft., or 2·8 miles. In 1859 the demand was for a reliable and cheap illuminant to replace the vegetable oils then in use. Kerosine fulfilled the demand and remained the chief product of petroleum for nearly forty years.

The next landmark in evolution of the petroleum industry was the incidence of the internal combustion engine, which presented the twofold problem of adequate supply of motor spirit and economic utilization of other crude oil products. Statistics show that in 1915 there were 15·8 tons of crude oil available per automobile registered, and in 1935 only 4·9. Nevertheless the demand for motor spirit was met by increasing its volatility and at the same time the yield of this product from the raw material. Hydrocarbons available in the natural gas from the casing heads of wells and in the gases or uncondensed vapours from distillation plants, for example, pentane and butane, were incorporated in the motor spirit fraction, thus increasing its volatility. Increase in yield by this method, however, was small compared with the impetus given to the industry by development of the cracking process, which proved to be a highly flexible technique both from the point of view of control of yields and character of products obtained. In fact, largely owing to the influence of the cracking process the yield of motor spirit from crude oils has been increased fourfold. In 1910 a yield of 13 per cent was obtained, while in 1940 the estimated figure was 55 per cent.

At this stage parallel evolution in the motor engine industry, involving higher compression ratios, created a demand for motor spirits of higher anti-knock value. That the petroleum industry met this demand is evinced by figures relating to the octane numbers of motor spirits in the United States. In 1931 the anti-knock value expressed in terms of octane-number and related to a standard C.F.R. engine was 58; in 1933 it was 67; and in 1940, 73. It so happened that crude oils produced from fields of younger geological age than those first discovered yielded motor spirits of higher octane number and also that cracking processes produced spirits of better anti-knock value, but whether this had been the case or not, evolution in the petroleum industry would not have been seriously retarded. Large-scale development of dopes, particularly tetra-ethyl lead, would have met the contingency.

Having solved the problem of production of high-quality motor spirit, refiners were faced with the difficulty of commercial utilization of the other components of crude oils. Consumers had to be convinced of the practicability of using fuel oil as an alternative to gas, which was in fact much easier to handle. Persistence was rewarded and when the Diesel engine came upon the scene suitable fuels were already available.

Study of figures for sales of Diesel engines (expressed in horse-power) in the United States indicate how great was the demand for this type of fuel:

1915	... ...	86,000
1925	... ...	536,000
1935	... ...	1,200,000
1939	... ...	2,726,000

The so-called space-heater for domestic purposes created a demand for a distillate intermediate in character between kerosene and gas-oil. The use of asphaltic bitumens for road-making, waterproofing, impregnating and a variety of other purposes became an established fact, and methods of blowing or oxidizing bitumens to suit them for particular applications were gradually perfected.

Then came the call for more and more aviation spirit, a product which had hitherto been considered of negligible importance and the small demand for which had been met by a volatile motor spirit. To-day it is a complex mixture of carefully selected components made by a variety of processes, and refiners are concerned not only with its production in vast quantities, but also in maintaining a high standard of purity.

In the early days of the industry there was a deplorable wastage of natural gas. Now it is harnessed for use in a variety of ways. The dry gas is used as a gaseous fuel in refineries and for industrial purposes, also for the manufacture of hydrogen by thermal decomposition and the production of carbon black by incomplete combustion. Ethane is cracked into the reactive unsaturated hydrocarbon ethylene from which by interaction with iso-butane is obtained neo-hexane, a valuable component of aviation spirit. "Bottled-gas" is produced by liquefaction of butane and propane by pressure at ordinary temperatures and is distributed in steel bottles for domestic cooking and lighting.

Finally, brief mention was made by Mr. Kewley of the ever-increasing number of special oils of the lubricating class, of the numerous new applications of paraffin waxes in the electrical and waterproofing industries, and of the uses to which are put the waste products from various refining processes, for example, naphthenic acids and cresylic acids.

All these data are amassed in support of the main theme of the paper, which is to demonstrate how successfully the petroleum industry has adapted itself to current demands and at the same time to adduce evidence pointing to the maintenance of this process of evolution in all its intricacies.

THE LIGHTNING DISCHARGE

AN official communication (Ref. *S/T* 18*a*) from the British Electrical and Allied Industries Research Association upon this subject has been published by C. E. R. Bruce and R. H. Golde (*J. Inst. Elec. Eng.*, Pt. II, Dec., 1941). The contribution is an important one, and it presents several new theses. It is considered that the potential required to cause a lightning discharge is only a small percentage of that hitherto believed necessary, namely, of the order of 5×10^7 volts as compared with Wilson's 1×10^9 to 6×10^9 volts. The energy involved in a flash is of the order of 250 kwh., while the average charge is of the order of 50 coulombs, or 50 per cent greater than had been previously accepted. About one third of this charge is probably neutralized in the intervening space charge.

Available statistical data show that thunderstorms all over the world have similar flash time characteristics and numbers of strokes per flash. Strokes to the Empire State Building, New York, were found to be similar in overall duration to those occurring in ordinary country, due allowance being made for the duration of the initial continuing stroke. The currents in the flashes, however, were greater than those in flashes to normal country. Evidence purporting to suggest that storms in temperate regions vary in the number of strokes per flash was found to be inconclusive, and it is suggested that the later strokes of a flash are less intense than the earlier ones. These successive strokes are initiated by streamers *from* the original stroke *to* other cloud centres, and it is thought that strokes to transmission line conductors which do not cause flashover are unlikely to be followed by subsequent strokes.

Support was obtained for the suggestion that the wave forms of atmospherics are due to successive reflexions from the ionosphere and not to current pulsations in the lightning channel.

Negative flashes to earth are more frequent than positive flashes, the ratio being considerably smaller in temperate than in tropical regions. The polarities of direct strokes to transmission lines are unobtainable from magnetic-link observations on transmission towers. A higher proportion of positive currents has been observed by the cathode ray oscillograph as compared with negative currents.

Norinder's values for individual stroke currents are shown to be in error, an important selective principle having been neglected when comparing these with magnetic-link data.

SOUTH AFRICAN PREHISTORY

A NUMBER of interesting articles are contained in the *Transactions of the Rhodesia Scientific Association*, 37 (April, 1941). It is good to learn that the study of the rock-shelter paintings of Southern Rhodesia continues, and the Hon. L. Cripps speaks of thousands of sites of which he has visited and made copies of paintings at some six hundred. This is no mean work, and his little paper, scientifically written so far as it goes, is, one hopes, only the precursor of a larger work. The author has continued to study the superpositions of the different coloured paintings (though making no mention of any changes of style or subject-matter) and by these means makes out an age-colour sequence not materially differing from that which I was able to suggest in 1928. Further, he considers that the paintings were connected with the burial of the dead, and that the present-day natives are the descendants of the artists. I venture to suggest that some at least of the paintings go back to a very remote period, and that much migration into the country has taken place since they were made. It is always difficult to deny continuity of blood in any given instance, but I doubt whether there is any general direct descent from the earliest painters to the modern inhabitants. Indeed, I am not even sure that the painters in claret were themselves the direct descendants of those who used the earlier colours. May I perhaps remind Mr. Cripps that the problem of dating the paintings will surely involve excavations in the sites and that Bambata and Nswatugi seem to point the way and have in fact already helped in this direction ?

Mr. K. Radcliffe-Robinson describes a Stone Age industry from the Wedza district, some three hundred yards from the Sabi River on the banks of a tributary. Dolerite is the chief material used. Implements of various types occur, and, if the industry is really homogeneous, the age cannot be very remote, although some handaxe-like types and a possible burin occur. But so does a polished tool ! The occurrence of burins in more or less recent levels has been noted by Schofield in Natal, and rough core tools somewhat of a handaxe type are also not unknown. The technique of polishing is not very common, but examples are known from Southern Rhodesia, and farther to the south, for example, there are local specimens in the Museum at Grahamstown. In no case does this technique appear to be very ancient so far as we can determine. At a part of the site a little distant from the main mass of these tools there was found a Rhodesian Stillbay industry of quartz and ironstone, but owing to the lack of any stratigraphy it is, as is so sadly usual in this country, impossible to prove any relative dating of the two industries. This paper, too, shows a scientific attitude to the problems of Rhodesian prehistory; the drawings are adequate but might have been better arranged.

Mr. C. Martin describes pottery-making in Nanyikaland, an art which is apparently dying out. As usual in Bantu tribes, pottery-making is woman's work. A good description and some interesting photographs are given.

M. C. BURKITT.

DRUG PRODUCTION IN THE BRITISH EMPIRE

IN a paper on "British Empire Drug Production" before the Royal Society of Arts on December 16 (*J. Roy. Soc. Arts*, 90, 138; 1942), Dr. Maurice Ashby points out that we are normally dependent on imports from overseas for practically the whole of our requirements of crude drugs, and a large proportion of our pre-war imports came from countries outside the Empire, the continent of Europe being our main source of supply of such vital drugs as belladonna, digitalis, henbane and stramonium. Dr. Ashby, after emphasizing the difficulties which might be encountered, owing to the influence of environment and inherent physiological differences, in growing medicinal plants in a new country where the climate or soil conditions might not be quite the same as in its original home, gave an encouraging account of what is being done in Empire countries to meet essential needs.

In Canada the most important development is the introduction of cascara as a crop, but some years will be required before supplies are available from the new plantings. In Australia and New Zealand the two most important items are agar-agar and ergot, and both Australia and New Zealand appear hopeful of producing really good-quality agar on a commercial scale.

Large-scale experiments on the artificial production of ergot on rye were undertaken in Australia on behalf of the British Government. New Zealand could probably produce most of the medicinal herbs we formerly imported from Central Europe, but the high cost of labour would make this uneconomic. With regard to India, Burma, Ceylon and Malaya, about 90 per cent of the world's supply of cinchona bark came from Java, which holds a virtual monopoly of the market. Indian production is still largely confined to Bengal and Madras, and has always aimed at satisfying local needs. Cinchona cultivation has been revived in Ceylon in recent years and there has also been experimental work in Malaya and Tanganyika. We have flourishing ipecacuanha industries in Bengal and Malaya but the quantities produced are very small, South America, particularly Brazil, being practically the only source of supply and, as ipecacuanha is a difficult crop to grow and takes some three years to mature, development must be slow. Malaya is also the leading producer of derris root, and strains have been developed with a far higher rotenone content than the original wild material or that produced by other countries.

The citronella oil industry of Ceylon has now assumed added importance, while in India karaya gum is proving a satisfactory substitute for some of the more costly gums like gum tragacanth and gum arabic. The Himalayas offer endless possibilities for belladonna, henbane, etc.

In the Mediterranean area the chief items are liquorice root and squill, particularly in Cyprus and Palestine. From South Africa the chief drug products are Cape aloes and buchu leaves. Cascara production in East Africa has been moderately successful and there has been experimental work on ephedra and on ocimum oils as a source of camphor, but the most striking success has been the pyrethrum industry.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chief Assistant to the Ayrshire Electricity Board—The Clerk to the Ayrshire Electricity Board, Greenholm Street, Kilmarnock (endorsed 'Chief Assistant') (March 2).

Senior Lecturer in Pathology, and a Junior Lecturer in Pathology—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (March 16).

Demonstrator in Botany at Westfield College, University of London—The Registrar, Westfield College, at St. Peter's Hall, Oxford.

Assistant Chemists, partly for Laboratory and partly for Process Plant Operation, for employment in the East—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1.

Colloid Chemist or Physicist—The Director of Research, British Pottery Research Association, Queens Road, Penkhull, Stoke-on-Trent.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Saturday, February 21

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 2 p.m.—Mr. L. C. Maitland: "Mining Timber, Possible Economies and Substitutes".

Monday, February 23

Royal College of Surgeons of England (at Lincoln's Inn Fields, London, W.C.2), at 2.30 p.m.—Prof. J. Beattie: "Physical and Chemical Changes in the Blood associated with Shock and Hæmorrhage".

Royal Geographical Society (at Kensington Gore, London S.W.7), at 5 p.m.—Geographical Films.

Tuesday, February 24

Royal Society of Arts (Dominions and Colonies Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. C. W. Wardlaw: "Banana Research at the Imperial College of Tropical Agriculture, Trinidad".

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Mr. Ewart G. Culpin: "Reconstruction after the War, with special reference to the Problems of Town and Country Planning".*

Royal College of Surgeons of England (at Lincoln's Inn Fields, London, W.C.2), at 2.30 p.m.—Prof. J. Beattie: "Physical and Chemical Changes in the Blood associated with Shock and Hæmorrhage".

Institute of Physics (Joint Meeting of the London and Home Counties' Branch and the Royal Photographic Society) (at the Royal Photographic Society, 16 Princes Gate, London, S.W.7), at 5 p.m.—Mr. E. R. Davies: "The Role of Photography in the Detection and Measurement of Radiation".

Wednesday, February 25

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. James Hogan: "The Post-War Home—its Interior and Equipment". 6: "Pottery, Glass and Plastics".

Coke Oven Managers' Association (Joint Meeting with the Institute of Fuel together with the Iron and Steel Institute and the Institution of Gas Engineers) (at the Royal Victoria Station Hotel, Sheffield), at 2.30 p.m.—Mr. J. G. Bennett: "The Future of Coke".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Dr. K. S. Sandford: "The Geology of Italian North Africa".

Thursday, February 26

Royal Institution (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Rt. Hon. the Earl of Onslow, G.B.E.: "The Preservation of the Existing Fauna of Great Gritain in a Wild State after the War".*

Friday, February 27

Institution of Mechanical Engineers (at Storey's Gate, London, S.W.1), at 2.30 p.m.—Mr. Hal Gutteridge: "Proneness to Damage of Plant through Enemy Action".

British Institution of Radio Engineers (Midland Section) (at James Watt Memorial Institute, York House, Great Charles Street, Birmingham 3), at 6 p.m.—Mr. G. Bernard Baker: "Thermionic Frequency Control".

Saturday, February 28

Royal Sanitary Institute (at the Nuffield Institute of Clinical Research, Oxford), at 10 a.m.—Mr. H. H. Crawley: "The Storage of Emergency Drinking Supplies"; Mr. Stewart Smith: "Administration of the Government Evacuation Scheme".

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conference on "Food Production and Distribution in relation to Nutritional Needs". (Speakers: Sir John Orr, F R.S., Dr. N. C. Wright, Mr. E. T. Halnan, and Sir John Russell, F.R.S.)

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section A (Mathematics and Physical Sciences). Vol. 61, Part 2, No. 13: Some Disputed Questions in the Philosophy of the Physical Sciences. By Prof. E. T. Whittaker. Pp. 160–175. 1*s*. 3*d*. Vol. 61, Part 2, No. 14: Further Investigations in Factor Estimation. By D. N. Lawley. Pp. 176–185. 9*d*. (Edinburgh and London: Oliver and Boyd.) [22

Hannah Dairy Research Institute. Annual Report for the Year ending 31st March 1941. Pp. 19+4 plates. (Kirkhill: Hannah Dairy Research Institute.) [22

Mines Department. Nineteenth Annual Report of the Safety in Mines Research Board, including a Report of Matters dealt with by the Health Advisory Committee, 1940. Pp. 36+3 plates. (London: H.M. Stationery Office.) 1*s*. net. [22

Imperial Forestry Institute: University of Oxford. Seventeenth Annual Report, 1940–41. Pp. 20. (Oxford: Imperial Forestry Institute.) [42

Other Countries

University of Illinois Engineering Experiment Station. Bulletin No. 330: Heat Transfer to Clouds of Falling Particles. By Prof. H. F. Johnstone, Robert L. Pigford and John H. Chapin. Pp. 58. 65 cents. Bulletin No. 331: Tests of Cylindrical Shells; a Report on an Investigation conducted by the Engineering Experiment Station, University of Illinois, in co-operation with the Chicago Bridge and Iron Co. By Prof. Wilbur M. Wilson and Emery D. Olson. Pp. 132. 1 dollar. Bulletin No. 332: Analyses of Skew Slabs; a Report of an Investigation conducted by the Engineering Experiment Station, University of Illinois, in co-operation with the Public Roads Administration, Federal Works Agency, and the Division of Highways, State of Illinois. By Prof. Vernon P. Jensen. Pp. 112. 1 dollar. (Urbana, Ill.: University of Illinois Engineering Experiment Station.) [32

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BIOLOGISTS IN WAR-TIME

'GUNS not butter' may have some merit as a war slogan but cannot be considered a good axiom for warfare. Without fats, with their high calorific value, there would not be the muscular energy to build more guns. In the strategical planning of modern wars the only sound precept is—guns *and* butter. Under conditions of emergency or unpreparedness it may be necessary to concentrate upon gun-production and neglect butter-making. This state of affairs existed in Great Britain before and during the early phases of the War, and the urgency of the demand for guns, tanks and aeroplanes, with all their associated equipment, laid great stress on the part the physicist, chemist, metallurgist and engineer could play in development and research.

Biologists during this first period of crisis well realized that they could not expect to be regarded as essential cogs in the war machine. They did, however, feel that as the first crisis passed, it would become evident that biologists had a contribution to make to the war effort. The Government was known to have recognized that the prolonged storage of reserves of grain and other foodstuffs is associated with special war problems concerned with mould, insect and rodent attack. These problems were already being investigated by biologists; it seemed likely that there would be further storage problems to investigate or advise on. In other fields there were encouraging signs that biologists could do useful work. Much attention was being given to the problem of crop failures and the incidence of wire-worms in the soil. There was, therefore, the feeling that there would be more war-time agricultural problems, but there was, however, the sobering reflection that wire-worms in newly ploughed up grassland had been a problem in the War of 1914–18 and that during the intervening decades little had been done to solve it. This was emphasized by Sir John Russell at the Conference on Science and the War Effort organized by the Association of Scientific Workers (see NATURE of February 21, p. 208).

By the middle of 1940 biologists first began to realize that they could not be expected to be directed into war work of a biological nature without themselves taking active steps to inquire whether problems existed or whether their biological knowledge could be put to a useful purpose. Already there was a tendency, not only among intelligent laymen but also among other men of science, to assume that in this War there was no place for biology—apart from the medical aspects—except in a few narrow fields. This attitude was not surprising, for to the non-biologist the progress in many other sciences, compared to that in biology, appears like the race between the tortoise and the hare. After a year of war the contest seemed even more unequal, and the physical sciences had a start. From the outset engineers, physicists and chemists had been mobilized in large teams to work in such specialized fields as radio location, chemical warfare and aeroplane design. Biologists in general had not had the advantage of co-ordinated team work. They also had the further handicap that many biological developments cannot have the dramatic appeal of the technical developments which lead to the production of a new fighter or a more effective bomb. Misunderstandings, too, concerning the importance of certain branches of biological research and results have also played a serious part during this War, as emphasized by Dr. A. Walton at the Conference to which reference is made above.

Another aspect of this unequal expansion of non-biological and biological research led to a large demand, especially in radio location, for biologists with a knowledge of physics. As a result many biologists who saw no prospect of being employed in a biological capacity joined up as technicians in the Services. To other biologists, who by this time were convinced that there were biological problems to be solved, this progressive depletion of the ranks was more than disturbing. There was also the further cause for anxiety since objections were sometimes raised that biological research was essentially long-range and therefore could not be brought to a successful conclusion in war-time. In agriculture, many of the research stations had lost most of their research staff for advisory work under the county war executive committees. This policy had the advantage of capitalizing the knowledge of experts in advising farmers, but had the disadvantage that simultaneous research at a number of research stations, so essential if reliable results are to be obtained in a minimum time, was seriously handicapped for lack of facilities.

Although in agriculture this switching of biologists from research to advisory duties indicated an official recognition that research workers are capable of making constructive use of their research experience, in other spheres there seemed to be little realization that a large capital of knowledge existed among biologists which if properly employed would return a handsome dividend. Biologists were convinced that wherever biological material was used or stored in large quantities there must be biological problems connected with supply, preservation, provision of substitutes, etc. Some of the problems, it was felt, were capable of immediate solution or only required short-range research. What appeared to be lacking was the appreciation that the problems existed and the absence of any mechanism by which information could be obtained or contacts established.

This was the background in the early part of 1941 when the Association of Applied Biologists, the British Ecological Society and the Society for Experimental Biology agreed to form a joint committee to consider what was the role of biology in war-time, what parts biologists could most effectively play and how their services or biological knowledge could best be brought to bear both on the problems and on the prosecution of the War.

As announced on p. 238 of this issue, a committee —the Biology War Committee—has now been set up which is recognized by the Government and is linked to a new joint committee of the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council.

The formation of this Committee is an important step forward and we heartily congratulate the three Societies on the important step they have achieved. Under the new procedure, biologists now have a channel through which problems, suggestions or ideas can be transmitted to the joint committee of the three Government research organizations and through it to other Government departments or the Services. Similarly, biological problems encountered by these departments or requests for information can be referred back to biologists through the same channel. In this connexion it is clear that if the proper contacts are to be established and the most correct information obtained, the Biology War Committee must be aware of the workers and their research in all the main biological fields. The course that the Committee has adopted initially of co-opting members so that each field of biology is represented by an expert is, in war-time, the only possible one if the Committee is from the outset to maintain the fullest liaison with biologists.

The setting up of this organization raises a number of important questions concerning the relationship of biology—excluding the medical aspects—to the community not only in war but also in peace. That such a committee should be in being only after two and a half years of war reflects the failure of the community as a whole to appreciate the true implications of biology and the part it has to play under war-time conditions. This lack of appreciation cannot be laid at a single door, but is brought about by a variety of causes. First, the teaching of biology in schools has had until recently scant attention compared to the teaching of physics and chemistry. Secondly, in the past the curricula of school biology have had a sterile academic flavour and little stress has been laid on how biology directly affects the lives of individuals. To-day in this respect there are indications of change, but the change has come too late to affect appreciably as yet the general outlook.

Furthermore, this welcome modification of biology from that of 'pure' botany plus zoology to the more comprehensive science of man and mankind is still being opposed by powerful authorities. Too many biologists still 'pride' themselves on their ignorance of the impact of their science on society.

Many biologists in our universities still look askance at applied biology. That outlook has had its repercussions right down to our primary schools, and herein, we think, lies the reason for the prevalent view, held even in many authoritative circles, that there can be very little *direct* use for biologists in our war effort. We welcome the founding of the Biology War Committee if only for the purpose of dispelling this out-of-date view; and, perhaps the Committee will succeed in rousing other biologists to their social responsibilities. The Committee might have another effect—that of counteracting the attempts of some biologists to disturb the relations of modern science to society under the pretext of preserving the freedom of scientific research. The establishment of this Committee in no way jeopardizes scientific freedom; rather will it help in the long run to preserve it.

The discoveries and technical developments of the non-biological sciences impinge directly on the life of every citizen, and it is literally brought home to him that science is affecting his way of life. That is seen especially in the sciences of physics, chemistry and engineering, in the development of radio, plastics and the motor-car. Because of his everyday familiarity with these products of science he learns to appreciate that each is a specialized field. He fully comprehends that a motor-car mechanic is not likely to be able to repair a radio set, and generally realizes that experts who design motor-cars do not design radio gramophones. But when it comes to biology, except perhaps in the farming community, biologists, when not classed as medical men, anthropologists or psychologists, may be distinguished as botanists and zoologists but no further. The idea is still prevalent that the sciences of botany and zoology are not like physics and chemistry, that is, widespread in their many fields, but sciences in which all branches come within the orbit of a single individual. It is not uncommon to find that a botanist's primary function is regarded as his ability to identify and classify plants, and it comes as a shock to learn that botanists may be interested in other things for which a knowledge of the physical sciences and mathematics is essential. For this prevailing view the biologists have largely themselves to blame. Is there, for example, any science other than biology which has found it necessary to form a society to deal especially with its 'applied' aspects. Yet nearly forty years ago certain more progressive biologists felt the need for such a society and thus founded the Society of Applied Biologists, which deals with those aspects of biology which ought to come within the purview of any general biological society. This Society, together with others equally as progressive and broad-minded, is now the very one to turn its attention to the value of its work to the war effort.

This misunderstanding of the scope and breadth of the biological field is in peace and war a serious handicap to the appreciation of what are biological problems or to what extent biologists can help in solving them or even preventing them arising. This misunderstanding brings in its train other misapprehensions. It is not always realized that biologists are not all equally competent to deal with every biological problem, and that for a given problem there is likely to be one kind of biologist who can solve it most effectively. It is not appreciated that most biological problems are complex and may for their solution require the united efforts of several different specialists not all of whom may be biologists. Nor is it fully understood that biologists have an important contribution to make by suggesting preventive measures.

It is to be hoped that the Biology War Committee by its activities will demonstrate how wide are the fields that the biological sciences cover and so bring home the value of biological research and study. The approach must, however, be twofold and the community educated to adopt a more biological outlook. As Sir John Graham Kerr points out in his communication in NATURE of February 21, p. 221, the training of biologists is at the present time at a discount though the lessons of biological study may find their application in the design of the fuselage of fighter aircraft or the correct size of a Government department. Biologists, in this respect, are, as we have already pointed out, themselves much to blame. They have not sufficiently brought home to themselves or to the layman that, apart from food production and dietetics, biology is concerned in such diverse things as corrosion in condenser tubes, the purification of coal gas, the preservation of structures in bombed buildings and the fouling of ships' bottoms.

Now, the foundation of the Biology War Committee, with its strong membership, will be able to change all this. We heartily endorse its being and terms of reference, and feel it is an occasion for congratulation that the Government views it with favour, since this Committee can, and must, do much, not only for our war effort, but also for biology itself. It can raise the science of biology from the slough of complacency in which it has wallowed for decades to the firm road on which it rightly belongs—that of a science not only of cultural value but also of inestimable practical value to the progress and evolution of civilization, a value on a par with that at present attached to the sciences of medicine, engineering, physics and chemistry.

PURITY AND FINE MEASUREMENT

Chemical Species (La Notion d'espèce en chimie)
By Prof. Jean Timmermans. Translated from the revised French manuscript by Prof. Ralph E. Oesper. Pp. ix+177. (London: Macmillan and Co., Ltd., 1941.) 18s. net.

PROF. TIMMERMANS of the University of Brussels and director of the International Bureau of Physico-Chemical Standards, was the author of a book entitled "La Notion d'Espèce en Chimie" which was published in Paris in 1928. This most useful little book has now been amplified to bring it up to date and very satisfactorily translated into English by Dr. Oesper with the title "Chemical Species". The book deals with these questions: What is a chemical species and how can a given physical-chemical system be defined without ambiguity ? How should a substance be refined so that it accords with such definition of purity ? And what precautions are necessary in the precise measurements of its constants ? There is much available data in the literature, good, bad and indifferent, but it is not always easy to know which are the best values to choose. Richter, the editor of "Beilstein", in an article on how that great handbook was compiled wrote, "the principles to be followed in such critical choices have been laid down by Timmermans": they will be found in Part IV of "Chemical Species".

The book is not a treatise; it is a statement of principles, illustrated by many interesting notes. Much of it is the common knowledge of chemists, indeed their stock in trade; but it would be difficult to find in any other publication the principles which govern the preparation of a pure substance and the conditions for the determination of its constants with known accuracy collected together and set out in a reasoned way so completely. It would be well that chemists should take note, so that the data which are being continually fed into the literature might carry greater 'weight' in the final assessment of the value of any measured constant.

The author, in discussing the nature of a chemical species, points out that in a thermodynamic system, the phase rule defines the distinction between aggregates, solutions, compounds and elements; for example, change of pressure will alter the composition of a constant boiling (azeotropic) mixture and show that it is not a compound. From the thermodynamic point of view, the mixture of *d*- and *l*- camphoroximes behaves as a single component; mixture is only established by change of configuration as shown by change of rotatory power. Timmermans directs attention to the difference in the position of the maxima in the freezing-point curves and the position of the maxima in curves of specific electrical conductivities for certain alloys and therefore the difficulty of attributing such maxima to the formation of compounds. So much light has been thrown on these questions by X-ray methods and by the studies of Hume-Rothery and others, that it would seem that the characterization of chemical species by X-ray analysis might have received some mention. Such methods have played a part in determining whether the red and yellow forms of lead oxide, cadmium sulphide, etc., are merely polymorphs or whether the difference is structural, and might have been referred to in the interesting discussion in Chapter 5 on polymorphism and isomerism.

There would not be much doubt about the characterization of a crystal of sodium chloride (chlorine isotope 35) as a distinct chemical species, but polymeric mixtures like water in dynamic equilibrium are not so unequivocably definable, and the majority of 'pure' materials do not consist of identical molecules but have to be considered as an intimate tautomeric mixture of different species of molecules. The system can only be completely characterized if the values of the factors determining the equilibrium are known. Such factors, for example, may be photochemical, as in the case of anthracene and dianthracene.

Timmermans discusses in Part I how a chemical system should be defined without ambiguity, and that leads to the question in Part II, how to prepare pure materials which permit the preparation of all possible chemical systems. He praises the work of the English chemists Perkin and Young in the extreme care taken as to the purity of the substances of which the rotatory magnetic power or stoichiometric properties were being determined. The purity required depends on the nature of the constant which is being determined; for example, a very small fraction of air in carbon dioxide will affect the critical pressure, but it might have little effect on other properties. There are many tricks in the preparation of pure organic substances; thus, the solubility of secondary butyl alcohol in water is very sensitive to presence of alcohols or ketones, so in making a pure specimen for solubility determination it is no use trying to reduce methyl ethyl ketone, for the reduction is never complete enough. Saponification of a non-volatile ester is also of little use because traces of alcohol remain from the alcoholic potash employed; by preparing the crystallizable monoester of the dibasic acid (phthalic acid), however, the danger of any contaminant during saponification is avoided. There are tricks, but many pitfalls, too; for example, the boiling point of benzene (b.p. 80·2°) is only changed 0·01° C. by 4 per cent of heptane (b.p. 98·4°). The use of adsorbents, drying agents, etc., the determination of constants as criteria of purity, the discussion of errors, the weighting of observations, units and the selection of standards of reference are some of the matters with which Parts II and III are concerned.

It is perhaps not generally realized how many stages are involved in the determination of temperature by means of a mercury thermometer. First there is the observation on the particular thermometer used with the determination errors of the particular observation (stem correction, etc.), then there is the comparison of the thermometer against a standardized thermometer, those are two stages. The standardized thermometer has to be compared from time to time with a thermometer used in the comparison baths at the standardizing laboratory; these would be standardized from time to time against a thermometer which is referred to the platinum resistance thermometer, which in turn has been referred to the gas scale by the elaborate investigations which have established the scale. Those are at least three further stages.

One of the most useful parts of the book is Part IV where examples will be found of determinations of physical constants and the weight to be given to such determinations. On p. 164 reference is made to the measurements of the critical point of benzene as an illustration of the weights to give to values found in the literature: the remark that the value measured by Sajotchewsky in 1879 which differs by nearly three per cent from the accepted value was 'very good', no doubt means that it was of passable accuracy at the early date when the measurements were made, but it would be a poor determination these days.

The final chapter refers to the great need for the provision of pure materials and the careful determination of their constants. Have not so many of the great advances in the past (for example, the discovery of argon) been made in this very quest?

A. C. Egerton.

THE LIFE AND WORK OF WILLIAM HALLOCK PARK

The Man Who Lived for To-morrow

A Biography of William Hallock Park, M.D. By Wade W. Oliver. Pp. 507. (New York: E. P. Dutton and Co., Inc., 1941.) 3.75 dollars.

ROBERT BRIDGES in a letter to Mrs. Henry Bradley, commented in these terms on his memoir of her late husband, the philologist, and one who had been for long his close friend: "It is a first essential in such literary portraits to write something which will engage the reader's attention." When judged by this test, Dr. Wade Oliver's book is a notable success, for it gives the reader a firm and attractive outline of the life and character of Dr. William Hallock Park and of the setting in which his work was done. Dr. Park was for many years director of the research laboratory of the Board of Health in New York City, and he held a well-earned reputation as an exponent of the first rank in the field of applied immunology. Not only so, but he also gained the respect and affection of the leaders of medical research throughout the world, as is witnessed by the generous tributes that were paid to him on the occasion, in October 1936, of the opening of the new laboratories in New York which were rightly named after him.

Park was truly a citizen of New York. Here, on December 30, 1863, he was born, and after a career at school and college which gave no promise of his mature qualities, he led a life of unremitting service in the application of microbiological knowledge to the control of epidemic diseases. He died on April 6, 1939, when he had passed his seventy-fifth year. As a medical student and also as a young graduate, he came under the influence of Dr. T. M. Prudden who, in 1885, was the first to teach medical bacteriology in New York City, and it was to him that Park owed his final choice of a vocation. For a time, however, his gropings in other directions showed him to be irresponsive to his real calling. Thus he graduated in medicine from a desire to become a medical missionary in Persia and in this way to maintain a family tradition. A post-graduate training in Vienna included courses in diseases of the nose and throat and in gynæcology. On his return to New York he was undecided whether to specialize in one or the other of these subjects, until a letter he wrote remained unanswered and in a moment of pique he resolved to practise as a throat specialist, and so became interested in the clinical features of diphtheria and the existing views on its bacteriology. Prudden, who had reached the wrong conclusion that Streptococcus and not the Klebs-Loeffler bacillus was the causal agent of the disease, offered to Park laboratory facilities to investigate the problem in his spare time, with the result that after two years work the etiological role of the diphtheria bacillus was clearly established.

Park's association with the Department of Health of New York City began in 1893 with his appointment to the modest post of inspector and diagnostician of diphtheria. His interest in the prevention and treatment of diphtheria by means of specific immunizing reagents never waned: he was indeed a pioneer in organizing the prophylactic immunization of children on a large scale. Thus, on May 15, 1933, when nearly seventy years old, he immunized, with due ceremony, the millionth New York City child against the disease; and his colleague, Bela Schick, the originator of the Schick test, performed the same service for the first child of the second million.

Park entered the stage of his life's work at an opportune and fortunate time, because then the new science of bacteriology was becoming more and more linked with the ancient study of epidemics, and was helping to free it from the baseless and often fantastic ideas of the older writers. The story which Dr. Oliver so skilfully unfolds of the epidemic history of New York is an enlightening one. In 1892 there were 241 cases of typhus fever with 45 deaths, and 10 cases of epidemic cholera with 9 deaths. In 1904 and 1905 a heavy epidemic of cerebrospinal fever and pneumonia fell upon the city; and in the latter year 3,585 cases of typhoid fever were reported in the Greater City of New York. Again, in the five months from June 1 to November 15, 1916, 8,928 cases of poliomyelitis were notified in this area. The pandemic year of 1918 accounted for 10,886 deaths from influenza and 9,722 deaths from pneumonia in the period September 15–November 16 in New York City. Park's ardour in fighting these plagues never cooled, and he published numerous papers on his investigations, either alone or jointly with his colleagues, who regarded him as an inspiring chief and who served him well.

A chapter is devoted to the problem of the contamination of milk and to Park's efforts to bring about improvements. Reference, too, is made to the discovery of the first case of a chronic typhoid carrier in the United States. Dr. George Soper, who tracked down the house epidemics for which this carrier was responsible, has contributed elsewhere a most interesting account of his inquiries ("The Curious Career of Typhoid Mary", *Bull. New York Acad. Med.*, **15**, 698–712; 1939); the bacteriological work was carried out in Park's laboratory. The sinister figure of Mary Mallon, who was either wholly heartless, or utterly ignorant, or was compounded of both these defects of mind and character, is likely to remain an historic warning of the tragedies which may follow the uncontrolled activities of a potential focus of infection in the person of a typhoid carrier.

Park's success as a director of research was founded on his simple and, at times, almost naive nature, and was supported by his patience, his perseverance and the integrity of his aims; he had a constant desire to help his fellows. He possessed a quiet sense of humour and revealed firmness of mind when the need arose.

The author of this book manifests an apt and pleasing choice in the quotations with which he prefaces the chapters. The portrait of his subject is worthily drawn, and the publishers also deserve praise for their part in the production of the volume.

MAN'S ACHIEVEMENT OF FLIGHT

The Birth of Flight

An Anthology by Hartley Kemball Cook. Pp. 204+8 plates. (London: George Allen and Unwin, Ltd., 1941.) 7*s*. 6*d*. net.

On December 17, 1903, the Wright Brothers made that flight of twelve seconds in a power-driven controlled heavier-than-air machine which was to change the history of the world. The aeroplane has, in a few flying years, altered the outlook of every man and woman in the world, whether he or she has ever flown or not, or even seen an aeroplane. When this War ends, it will alter it still more, for flying will be as much of the world's everyday experience as travelling by rail or steamer is now.

"The Birth of Flight" is a pleasant corrective to the present attitude towards flying. It begins with the mythology and ends with the accomplishment of flight. Much is from contemporary records. In 1670 we find Francesco Lana, who considered air-exhausted spheres acting as balloons, writing, "God would never allow such a machine to be successful since it would create many disturbances in the Civil and Political Government of Mankind." Its success has certainly borne out Lana's prediction, though his theology was wrong. The Royal Society, not long after its foundation, made some inquiries into the art of flying and drew from Dr. Henry Stubbe the caustic comment that "flying was an art in which they have not as much as effected the most facile part of the attempt, which is to break their necks".

In 1783 Montgolfier flew his first hot-air balloon, quickly followed by the hydrogen balloon. For the first time man left the ground and Walpole wrote, "all our views are directed to the air." In a few years France and England had become balloon-minded.

In 1785 Dr. Jefferies crossed the Channel in a balloon, causing as much sensation as Blériot did well over a century later. In the 1860's Coxwell and Glaisher reached a height of seven miles. The balloon played its part in the American Civil War, in the Franco-Prussian War, and a balloon section was formed in the British Army, out of which ultimately came the Royal Flying Corps and the Royal Air Force. Now we have the balloon barrage.

The author only briefly touches upon the coming of the aeroplane. There is, however, one quotation worth recording, from an interview given by Rudolph Martin, a German: "In a world war Germany would have to spend millions on motor airships and a similar amount on aeroplanes to transport 350,000 men in half an hour during the night from Calais to Dover. Even to-day the landing of a large German army in England is a mere matter of money." As the author comments: "there is not enough money in the world for the purpose."

The author has chosen here and there from the story of the conquest of the air, and has chosen well. This is a book for quiet reflection, for those moments when the alarm has not been sounded, for a consideration of those words of Camille Flammarion, in the nineteenth century, writing of the coming conquest of the air: "There would no longer be frontiers but only peoples, and the whole earth will be a Confederation of United States, living in might and liberty."

J. L. PRITCHARD.

A FRENCHMAN'S VIEW OF PREHISTORY

Prehistory

By Prof. A. Vayson de Pradenne. Authorized translation by Ernest F. Row. Pp. 239. (London: The Scientific Book Club, 1941.) 2*s*. 6*d*.

ORIGINALLY trained as an engineer, M. Vayson de Pradenne was a well-to-do Frenchman with a château in Vaucluse and a flat in Paris, a married man with children. Towards the beginning of the present War tragedy overwhelmed the family. With the exception of one child, all were killed in the Paris flat by fumes from a defective stove. Vayson had for long been interested in prehistory, especially in the earlier periods. He bought up nearly the whole of the vast collection of Lower Palæolithic tools so carefully got together by the late V. Commont from the gravels of the Somme in the Amiens district, and had intended, later in life, to write for it a *catalogue raisonné*. He brought to bear on the whole subject a keen and trenchant mind and was only too happy to differ from the accepted or orthodox views. His common-sense outlook on a problem was often like a breath of fresh air in a crowded room—even if to some of the inmates it may have been felt as a draught! He was accorded the titles of "Directeur à l'école des Hautes Études" and "Professeur à l'école d'Anthropologie", and he also had a finger in the pie at the Trocadero, but none of these posts involved any regular teaching or research. Indeed, Vayson always remained the amateur—with the merits and faults of his kind.

Though the reviewer, himself a 'professional', is one of those who feel strongly that the professional owes a great part of his knowledge of prehistory to the amateur—that the former marches forward to a great extent on the trail blazed by the latter—yet none the less there is usually a lack of co-ordination to be felt in the work of the amateur, a criticism from which Vayson cannot wholly escape. His book is an epitome of himself and gives an excellent general, world-wide survey of his subject extending into Neolithic times. It will not be of much use to the specialist, but for the general reader it will help to stimulate interest in a fascinating branch of study and will serve as an undetailed book of reference to those who, having already a little information, would like a summary of what is known of prehistoric times in this or that part of the world. After all, Vayson was in the inner ring of prehistorians, he knew his subject and was not merely a scissors and paste hack hired by a publisher to write a work on prehistory for the benefit of the latter's pocket!

Part 1 deals with definitions, scope, method, interpretation of data and technology; Part 2 with classifications and chronology in western Europe, and Part 3 with prehistoric material from various parts of the world. There are a number of simple and convenient tables and the illustrations are adequate. There is no bibliography. In the original French version a short, exclusively French, bibliography was appended; it is perhaps a pity that the translator, who has done his work well, did not see fit to add a list of references suitable for English readers and which would have enabled them to delve deeper into the subject had they desired to do so as a result of the stimulus of Vayson's work. Knowing the book in French, one was at first inclined to wonder whether a translation was really called for: whether the book would really fill a gap in English libraries. On the whole it was, however, probably worth while, and one is glad in any event that Vayson's name should be thus perpetuated on our bookshelves.

M. C. BURKITT.

PHYSICAL GEOGRAPHY

The Earth and its Resources

A Modern Physical Geography. By Prof. Vernor C. Finch, Prof. Glenn T. Trewartha and M. H. Shearer. Pp. x+634. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 17*s*.

FROM the title of this book one might expect to find a treatment on fresh lines, with the selection and arrangement of its matter governed by the relevance of the materials to human needs. It is in fact a sound text-book on quite conventional lines. Its relation to a previous work is stated in the preface (p. vi) as "The content and organization have come largely from *Elements of Geography*, a college text by two of the authors. The third author . . . with the background of . . . teaching experience in secondary schools . . . has restated the subject matter for use at that level of instruction." It is added that the accompanying laboratory manual provides sufficient work for two semesters, with a hint that possibly it may be confined to one semester. The book could be used for the physical geography of the last year of the high school; it assumes a good elementary knowledge of the home country (United States of America).

The treatment is deductive in that general principles are simply stated, results are drawn from them and these are then illustrated by particular facts, used as examples. For instance, Chapter 11, p. 288, starts "Imagine that Fig. 186 represents a plain about 500 miles long. A glacier, centred at A, slowly pushes its way southward. . . ." To a reader familiar with the subject it is clear that this hypothetical case is a very simplified version of the glaciation of either North America or Europe. The deductions as to the features of glaciated land are similarly begun from diagrams of theoretical, imagined surfaces which are equally recognizable as generalizations (for example, Figs. 190, 201, 205), each of which is followed by specific examples of the feature discussed.

This kind of treatment may well give the student the impression that our knowledge of the phenomena is obtained from such hypotheses. In fact, as the authors well know, what happened was (1) the observation and record of a large number of facts, (2) comparison and classification of these, (3) the development of possible hypotheses for the generalization and 'explanation' of the facts, (4) the testing of the hypotheses by further observation and survey and, where possible, experiment; and only those hypotheses which have survived this testing are now accepted. While it is true that no text-book can set these steps out in full over the whole of its fields, it would be better to follow this order, so as to leave the student with the knowledge that a scientific hypothesis, or theory, is to be judged by the success with which it fits both the facts it was devised to 'explain' and any other relevant facts which may come to light later. Hence if a better hypothesis is devised, the less satisfactory one will be abandoned. Physical geography contains abundant material for such study; and, as a teaching method, it may well be preferred to the presentation of present-day hypotheses as if they are unquestioned truths.

The book is very well illustrated and produced. Although it is a first edition, the present reviewer has noticed no important error or misprint. The appendixes are, for the most part, useful; but Appendix D, "The Interpretation of Maps", does not add anything to what the pupil should know before reaching this stage; while the seven maps which conclude the volume are quite inadequate to illustrate the work although their presence may be regarded as suggesting that the reader does not need an atlas.

C. B. FAWCETT.

THE SOCIOLOGY OF MEDICINE

Medicine and Mankind

By Arnold Sorsby. Pp. 256+16 plates. (London: Faber and Faber, Ltd., 1941.) 12*s.* 6*d.* net.

ADVANCES in medicine and the allied sciences have of recent years been very great; it is no exaggeration to say that the change both actual and potential in only one generation of time has been exceptional. This increase in degree and direction of knowledge cannot be wholly regarded as technical detail interesting to the practising physician in the conduct of his profession; it comes, on the contrary, directly within the concern of the intelligent man in the street, for the prevention and treatment of disease are matters which impinge immediately upon his personal life. Immunization against diphtheria may be cited as an example; it is now an established method, easy in performance and satisfactory in practice, yet it has been carried out in Great Britain on a scale which can only be described as petty compared with the extent practised in the United States. The difference is almost entirely due to the respective efficiencies of the campaigns bringing the matter to the notice of the general public.

It is not only advantageous in his private life that the ordinary man should have some knowledge of these developments, it is important from a social point of view; public opinion has to be educated to appreciate the trend and movement of work which steadily intrudes more and more into all aspects of human life. For good or ill, man has become a community animal. Civilization brings manifold consequences; it means responsibility as well as advantages. Measures for communal welfare are not brought to efficiency by being placed upon the statute book, but by the active support of an educated public.

Books, therefore, which seek to bring anyone of matriculation standard in touch with the current findings, purposes and possibilities of modern science deserve an important place. "Medicine and Mankind" is of this type. Dr. Sorsby succeeds admirably in the picture he gives of present-day medicine. He is greatly aided in this task by the adoption of a simple straightforward design which allows balance and proportion in the subject-matter.

Dr. Sorsby, opening with an account largely historical of the relations between health and disease and the theses which have governed our attitude at different stages of progress, goes on to a statement of health from the physical point of view. He then proceeds to discuss in sequence the ill-formed body, the ill-balanced body, the abused body and the assaulted body. This enables him to set out in due proportion such diverse subjects as experimental embryology, endocrinology, dietetics, including the accessory food factors, the new dye-stuff medication, allergy and bacteriology. Treatment equally has its place and is conveniently divided into chapters on individual and collective measures.

Under the heading "Social Achievements and Frustrations" Dr. Sorsby takes up various aspects of morbidity, mortality, environment, nutrition, occupation and related factors of importance; this is perhaps his best chapter. While he directs attention to the persistence of many preventable conditions, he avoids polemics on the culpable aspect, for there are, of course, environmental conditions to-day the continuation of which infers ignorance or inattention on the part of responsible public opinion.

Dr. Sorsby is obviously interested in the special problems appertaining to nature and nurture. He therefore allows himself rather more space on questions of genetics and environment, but as these subjects represent an active fringe of medicine, active in its justifiable inferences as well as its real or immediate effects, this latitude cannot be regarded as altogether out of place. He omits all reference to psychological matters. This depends apparently upon a question of space, but the omission in a sense enhances the value of the book. For it allows a restriction of the contents to purely physical aspects which certainly offer enough to think about.

"Medicine and Mankind" is a competent and careful study. It should be of use to the practising physician anxious to keep in touch with the broad lines of thinking medicine; it should also be of use to the man in the street with sufficient intelligence to appreciate his limitations. There are numerous illustrations which have been happily chosen to simplify the subject-matter and enhance its application.

JOSEPH GEOGHEGAN.

THE BIOLOGY WAR COMMITTEE

DURING 1940 meetings were held at which the place of the biological sciences and the role of biologists in war-time were discussed by the British Ecological Society, the Association of Applied Biologists and the Society for Experimental Biology. As a result of these discussions each of the societies appointed a sub-committee to review the position and make further inquiries as to the nature of war problems. Early in 1941 the sub-committee of the societies agreed to form a joint committee and after several meetings formulated a number of proposals as to the best means of mobilizing both biologists and biological knowledge in the national interest.

In May, the Committee of the three societies was informed that the Agricultural Research Council jointly with the Department of Scientific and Industrial Research and the Medical Research Council had considered the proposals as to the application of biological knowledge to problems arising out of war-time conditions and the fuller use of the services of biologists during the War. They had, therefore, created a small Joint Committee to carry out "the declared policy of H.M. Government to make the fullest possible use of science to assist the Nation in its war activities" and to confer "on the further steps which might usefully be taken to carry this policy into effect so far as the biological sciences are concerned". The Joint Committee invited representatives of the Committee of the three societies, as being an organized body dealing with this matter, to meet them, and the following scheme was put before this Joint Committee.

It was proposed that, *vis-à-vis* the Joint Committee of the Government research organizations, the Committee of the three societies should be expanded into a larger committee representative of all the main aspects of biology and that this larger committee—the Biology War Committee—should co-operate with the Government Committee in the following ways:

(1) Act as a clearing-house through which problems or ideas coming from biologists can be brought to the notice of the Joint Committee of the Government and through it transmitted to the appropriate Government Councils or Departments.

(2) Provide a channel by which the Government can refer problems to biologists.

(3) Direct the attention of the Government to any results of current biological research which the Committee considers to be apposite to the war effort.

(4) Prepare reports or memoranda on any aspect of the War which is essentially biological or which has biological implications and to submit such reports to the Joint Committee of the Government research organizations.

In connexion with this scheme the Joint Committee of the Government research organizations wishes to stress that the proposed machinery is to supplement the existing contacts with biologists and in no way seeks to disturb the connexions already established. Heads of university departments, research institutes or research stations who are already in touch with the Department of Scientific and Industrial Research, the Medical Research Council or the Agricultural Research Council would, therefore, continue to communicate direct with the Council or Councils in regard to their recognized field or fields of investigation. Similarly, biologists who are undertaking specific investigations for Government Departments or the research organizations should continue to deal with the Department or Council concerned in regard to those researches in which they are already engaged. With these provisos, the Government Joint Committee is most anxious that, to avoid undesirable complications, biologists shall submit all proposals or suggestions to the Government only through the Biology War Committee.

The original Committee of the three societies, in accordance with the suggestion put forward by the Joint Committee of the Government that the representation of the biological sciences should be as wide as possible, has given careful consideration as to how the original committee should be modified with a view to adequate representation of subjects. It was felt that, while the Committee should cover through its membership the main fields of biology, medicine should not be included, and that the representation should be weighted in favour of those fields which are not highly specialized and in which workers are not already closely linked with the three Government research organizations.

Members of the Committee of the three societies considered that, since at the outset, the work, scope and future of the Committee could not be foreseen, it would be unwise to limit the membership or to draw up a fixed constitution. They were of the opinion that the number of members should not be so great as to impede, especially under war-time conditions, both its efficiency and ability to make rapid decisions, but they also thought that while primarily the representation should be concerned with the main divisions of the biological sciences, yet there should also be some liaison with biological societies. After careful consideration the original committee co-opted fifteen additional biologists, expert in particular fields of biology. Afterwards the Committee approached the biological societies on the question of further liaison. The Committee suggested that, as a preliminary working mechanism for such liaison, biologists, under the exigencies of war-time and in view of the need for the Committee to function as soon as possible, would for the time being accept the arrangement that each biological society would nominate from the existing twenty-three members of the Committee a representative of the Society who would put before the Committee any views that the Society wishes to express and also report to the Society on the activities of the Committee; but here again it must be emphasized that the representation aimed at is that of subjects and not of societies as such.

It is clear that the whole question of the constitution of the Biology War Committee and its relationship with biologists must involve considerable time and discussion with the societies. In view of the fact that a number of biological societies have already offered support to the scheme the Biology War Committee has decided that it should make this preliminary announcement of the formation of the Committee and its personnel to date. It would like again to stress that the composition and numbers are provisional, and it is envisaged that alterations or additions will be made as circumstances arise. The Committee is, so far, constituted as follows:

† * G. E. Blackman (secretary), Department of Botany, Imperial College of Science and Technology, London;

* Prof. W. B. Brierley, Department of Agricultural Botany, University of Reading;

† * Prof. P. A. Buxton (chairman), Department of Medical Entomology, London School of Hygiene;

Prof. H. G. Champion, Imperial Forestry Institute, Oxford;

Prof. A. C. Chibnall, F.R.S., Department of Biochemistry, Imperial College of Science and Technology, London;

Dr. E. M. Crowther, Chemistry Department, Rothamsted Experimental Station, Harpenden;

Dr. C. Elton, Bureau of Animal Populations, University of Oxford;

* Dr. W. P. K. Findlay, Forest Products Research Laboratory, Princes Risborough;

† * Dr. H. Godwin, Botany School, University of Cambridge;

Dr. J. Hammond, F.R.S., Animal Nutrition Research Institute, Cambridge;

Prof. A. C. Hardy, F.R.S., Department of Biology and Oceanography, University College, Hull;

Prof. J. S. Huxley, F.R.S., Zoological Society, London;

† Dr. H. Martin, Long Ashton Research Station, Bristol;

Dr. A. T. R. Mattick, National Institute for Research in Dairying, Shinfield, near Reading;

* Prof. J. W. Munro, Department of Zoology and Applied Entomology, Imperial College of Science and Technology, London;

Dr. J. Needham, F.R.S., School of Biochemistry, University of Cambridge;

Dr. C. F. Pantin, F.R.S. (vice-chairman), Department of Zoology, University of Cambridge;

* Dr. O. W. Richards, Department of Zoology and Applied Entomology, Imperial College of Science and Technology, London;

* Dr. M. A. H. Tincker, The Laboratories, Royal Horticultural Society, Wisley;

† * Dr. C. H. Waddington, Department of Zoology, University of Cambridge;

Dr. T. Wallace, Long Ashton Research Station, Bristol;

Dr. E. B. Worthington, Freshwater Biological Association's Laboratory, Wray Castle;

J. Z. Young, Department of Zoology, University of Oxford.

In conclusion, although the full Committee has only been in existence a short time, it has been very active. The Committee is inquiring into a number of suggestions and problems raised both by biologists and by the Government. These cover a surprising range of topics and many of its activities relate to confidential matters, in respect of some of which the Government has accepted the Committee's proposals.

Biologists who wish to put forward suggestions, proposals or problems under this scheme should communicate with G. E. Blackman, Hon. Secretary, Biology War Committee, Imperial College of Science and Technology, London, S.W.7, or with other members of the Committee. In this connexion it is pointed out that under the terms of reference all such suggestions are communicated to the Joint Committee of the Department of Scientific and Industrial Research, Medical Research Council and Agricultural Research Council which will, if necessary, refer them to the appropriate Government Departments for consideration. In the first instance all suggestions are couched in general terms and in an anonymous form.

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* Members of the original joint committee of the Association of Applied Biologists, British Ecological Society and Society for Experimental Biology.

† Members of Executive Committee.

METEORITES AND THE AGE OF THE SOLAR SYSTEM

By W. J. ARROL, R. B. JACOBI
and PROF. F. A. PANETH

BETWEEN the years 1928 and 1931 several papers on the age of iron meteorites were published, based on analyses of their helium and uranium content[1]. The last paper gave age values for twenty-two iron meteorites which were fairly evenly spread over periods ranging from 100 to 2,800 million years.

It was pointed out in this paper that the helium measurements were considered satisfactory, while the method used for the estimation of uranium still lacked in accuracy and was to be replaced by an improved one[2]. Owing to external circumstances these experiments had to be abandoned after two years, and before final results could be achieved[3]. A new attempt to increase the accuracy of the age determinations was begun in 1937 in the Chemical Laboratories of the Imperial College of Science and Technology in London, and has been continued since 1939 in those of the University of Durham. Since general conditions a while ago again enforced an interruption, we propose to describe here briefly the main alterations made in the method, and the results so far obtained.

(1) The meteorite material used for each determination was increased to 15–20 gm. (2) The large quantities of hydrogen evolved by its dissolution in hydrochloric acid were burned with oxygen in a special device developed in connexion with another problem[4]. (3) Alternatively, the meteorite was dissolved, without evolution of hydrogen, in a reagent consisting of cupric and potassium chlorides and hydrochloric acid. (4) During this process sometimes not only the helium but also the radon liberated from the meteorite was collected and measured[5]. (5) After dissolution, the radium and thorium-X contained in the meteorite were precipitated, together with barium, as sulphates, and converted into chlorides. (6) The thoron and radon evolved from these chloride solutions were measured in an ionization chamber connected with an electrometer valve[6]; the thoron immediately after preparation of the solution in a constant nitrogen stream, the radon after regeneration and transference into the chamber. (7) The α-ray emission from the thoron and radon respectively was recorded photographically[7] over periods of some twenty hours. (8) The radon measurement was repeated at least once after a few weeks time.

The combined effect of these various changes has considerably improved the accuracy of our activity measurements, as control experiments showed. If quantities of radium of the order of 1×10^{-13} gm. (corresponding to an equilibrium amount of uranium of 3×10^{-7} gm.) and of (aged) thorium salts of the order of 1×10^{-6} gm. were added to the reagents, and the radium and thorium-X precipitated and measured as described, the agreement was good within about 10 per cent. It was especially gratifying that it thus became possible for the first time to determine the thorium content of iron meteorites[8]; previously, it was not known to what extent the age values calculated on the basis of the helium and uranium contents only might be too high, but it now appears that consideration of the thorium has little influence on the result, least of all in the case of the oldest meteorites.

In the main, the age values are determined by the helium and uranium content; "uranium" is here understood to comprise "actino-uranium" as well. This isotope, although not a member of the uranium-radium series, is known to be present in constant proportion[9], so that the radon content is a measure of it too. Owing to its comparatively short half-life period, it is responsible for most of the helium[10] in the oldest meteorites, and the somewhat indirect method of its evaluation necessarily introduces a certain degree of inaccuracy which, however, does not seem to exceed that due to the other sources of error[11].

A repetition of the helium and uranium analyses of several of the meteorites examined before 1931 showed that the old helium values are reliable; small corrections in a few cases are without appreciable influence on the main conclusions. The old uranium values, however, were found to be in most cases too high. It is, unfortunately, impossible to give a certain explanation for this deviation; it is not unlikely that most of the large glass vessels[12] used for the meteorite solutions in Königsberg liberated during the time of radon accumulation a sufficient amount of radon from the walls to falsify the figures. Since this assumption, however, cannot now be checked, we give it only as a tentative explanation. There is no doubt about the greater reliability of our present method of determination, into which the various improvements have been introduced; in particular, the small bulbs now used for the accumulation of radon did not, when tested, show of themselves any measurable radon activity.

The lower radon values now obtained made us particularly anxious to convince ourselves that no activity was lost in the process of extraction of radium from the meteorite; for this reason we not only used two different solvents (see above) but tried to compare also in several instances the radon regenerated from the radium-containing solution with the radon occluded in the solid meteorite; the agreement was very satisfactory and does not seem to leave any uncertainty as to the genuineness of the low activities as revealed by our new measurements.

We have concentrated mainly on six iron meteorites chosen for their widely differing helium contents; of the meteorite "Thunda" as many as seven samples were analysed, of the others only two to four. In all cases we feel confident that further investigation will not alter the result greatly, although we hope, in a later resumption of the work, to be able to narrow down the limits of error. These are greatest still in the thorium, and negligible in the helium measurements. (As an illustration of the difficulties arising from the extraordinarily low radioactivity of iron meteorites, it may be mentioned that the average uranium content of a 20-gm. sample causes in our ionization chamber only 8, the thorium content not more than 2, α-rays an hour.) It would take too long to attempt here a discussion of the probable error of the calculated new age values; we give them in round figures to indicate that only approximate data are at present obtainable[13]. We do not believe, however, that the highest ages are wrong by more than ± 1,000 million years, and the lower ones by more than a proportional amount, namely, about 20 per cent.

There is, however, one principal objection which might be raised against all age calculations based on the helium, uranium and thorium content: the fact that beryls and a few other minerals contain more helium than can be accounted for by the disintegration of their uranium and thorium within the geological periods during which they have existed in the solid state. (A helium deficit, caused by the escape of this gas, can occur only in minerals but not in iron meteorites[8].) So long as the origin of this 'surplus helium' is not explained, one has to be sceptical about the reliability of all the age values calculated by the helium method. This point has recently been stressed by Keevil after his discovery that, in addition to the cases of beryllium and potassium minerals detected long ago by the present Lord Rayleigh, some magnetites too contain surplus helium[14]. It will be very interesting to learn whether the magnetites which abound in helium have a peculiar chemical composition, for in the case of beryls it has been shown as very probable that not the suspected element beryllium but some other element, believed to be stable, is actually disintegrating with helium production[15]. The variety in the chemical composition of beryls (which has not yet been critically related to their helium content) gives scope to this possibility. All iron meteorites, on the other hand, are very similar in composition (see below); this, and the fact that, unlike minerals, they do not permit of any helium or radon migration, renders it rather likely that the differences in their helium contents are due to differences in geological age, thus making the application of the helium method possible.

In spite of the present doubt as to the value to be attached to the helium method, we think it worth while here to put our results on record; not only because of our belief that the method is admissible for such uniform and helium-tight material as iron meteorites, but also because we think it necessary to correct our old experimental figures, irrespective of the certainty of their interpretation. If age values of iron meteorites are to be mentioned at all, the results given here and not those previously found should be quoted. Moreover, the radioactivity of iron meteorites has been used in the discussion of geophysical questions; these calculations too will have to be revised in the light of our new measurements.

In Table 1 we have entered against each meteorite the class it belongs to (O = octahedrite, H = hexahedrite, f = fine, m = medium, g = coarse), its nickel,

Table 1.

Name of Meteorite	Class	Nickel (per cent)	Uranium (10^{-8} gm./gm.)	Thorium (10^{-8} gm./gm.)	Helium (10^{-6} c.c./gm.)	Age in millions of years calculated from	
						individual measurements	average activity
Bethany, Goamus	*Of*	8	1	4	0·15	60	75
San Martin	*H*	5·3	0·6	8	1·6	500	800
Bethany, Amalia	*Of*	8	1	4	3·0	1100	1500
Carthage	*Om*	7·7	0·5	4	25	6500	5800
Thunda	*Om*	8·5	0·8	4	28	6100	6200
Mount Ayliff	*Og*	6·6	0·4	2	40	7600	6800

TABLE 2.

Name of Meteorite	Class	Nickel (per cent)	Helium (10^{-6} c.c./gm.)	Age in 10^6 years
Cape York, Savik	*Om*	7	<0·0002	<0·11
,, ,, Ahnighito	*Om*	8	<0·001	<0·55
Bethany, Goamus	*Of*	8	0·15	75
,, Amalia (Foote)	*Of*	8	0·2	110
,, Gröndorn	*Of*	8	0·2	110
,, Lion River	*Of*	8	0·2	110
Coahuila	*H*	6	0·2	110
Uwet	*H*	6	0·4	220
Braunau	*H*	5	0·5	270
Cañon Diablo	*Og*	7	1	550
Cape York, Dog	*Om*	8	1	550
,, ,, Woman	*Om*	8	1	550
Magura	*Og*	7	1	550
San Martin	*H*	5	1·6	800
São Julião de Moreira	*Ogg*	6	2	1000
Seeläsgen	*Ogg*	6	2	1000
Murnpeowie	*Og*	6	2	1000
Mount Joy	*Hb*	5	2	1000
Copiapo	*Ob*	9	2·5	1250
Bethany, Amalia (Krantz)	*Of*	8	3	1500
Santa Rosa	*Ob*	7	3	1500
Nejed	*Om*	7	4	2000
Tamarugal	*Om*	8	4	2000
Henbury	*Om*	7	5	2400
Cranbourne	*Og*	7	5	2400
Augustinovka	*Of*	8	5	2400
Toluca	*Om*	8	6	2700
Arispe	*Ogg*	7	7	3000
Mooranoppin	*Ogg*	7	7·5	3200
Narraburra Creek	*Off*	10	11	4100
Wichita County	*Og*	8	11·5	4200
San Angelo	*Om*	8	12	4400
N'Goureyma	*Ob*	9	14	4700
Cosby's Creek	*Og*	7	14	4700
Hraschina	*Om*	9	15	4800
Sacramento Mountains	*Om*	8	15	4800
Seneca Falls	*Om*	8	15	4800
Charcas	*Om*		16	5000
Silver Crown	*Og*	8	17	5200
Staunton County, Mass. III	*Om*	10	19	5400
,, V	*Om*	9	19	5400
Joe Wright Mountain	*Om*	8	19	5400
Burlington	*Om*	9	19	5400
Nelson County	*Ogg*	7	20	5500
Williamstown	*Om*	7	21	5600
Lenarto	*Om*	9	22	5700
Carthage	*Om*	8	25	5800
Thunda	*Om*	8	28	6200
Yardea	*Om*		30	6300
Mount Ayliff	*Og*	7	40	6800
Morden			40	6800

uranium, thorium and helium content, and, in the last column but one, the age calculated from the three preceding figures. The following conclusions can obviously be drawn. (1) The helium content of the six iron meteorites studied varies greatly. (2) The uranium and thorium contents of these meteorites are confined within narrow limits; considering the still somewhat unsatisfactory state of our activity measurements we are not sure whether these variations exceed those found occasionally in samples of one and the same meteorite. (3) The remarkable uniformity in the uranium and thorium content is in good agreement with the great similarity displayed by all iron meteorites in their main chemical composition as indicated by the percentage of nickel in the above table, the rest being practically all iron. It may be added that it has been shown that all of them contain about 0·6 per cent cobalt, and traces of copper, chromium, carbon, sulphur, phosphorus, and of most of the other elements for which the methods of detection are sensitive enough; the quantities in which these elements are represented[16] scarcely vary from one meteorite to another to an extent exceeding the possible limits of analytical error. (4) The ages calculated for the three meteorites with the highest helium content amount to 6,000 and 7,000 million years.

This last result is of special interest if compared with current views on the age of the earth, the solar system, or the universe. A few years ago there seemed to be reasons to believe that the highest age found by radioactive methods for rocks and minerals in the earth's crust, about 2,000 million years, coincided with the age found by entirely different methods for the solar system or the universe[17]— a rather surprising result. The authors of a more recent survey[18] come to the conclusion that various astronomical lines of evidence make it probable that the universe must be less than 10^{10} years old, without, however, giving a lower limit. If our highest figures for the age of meteorites are considered together with the evidence implying that meteorites have since their formation been members of the solar system[19], we are led to the conclusion that the age of the solar system cannot be less than 7,000 million years, that is, considerably more than the age of the oldest rocks in the earth's crust. This figure would definitely exclude an age of only 2,000 million years which a bold extrapolation from the data of the 'expanding universe' seems to suggest.

It might be asked whether there is much chance that a search among other iron meteorites would discover some with greater quantities of helium, indicating still higher ages. It may, therefore, be useful to give here a list, which includes the values published in 1931 and later measurements, of all the iron meteorites so far examined for helium. It appears that among fifty there is none exceeding the helium content of the meteorite "Mt. Ayliff" included in Table 1. Altogether there are about 450 iron meteorites in museums; but the probability of finding one with much more helium does not seem to be great, considering that, beyond a helium content of about 10×10^{-6} c.c./gm., the number of specimens within constant helium ranges decreases rapidly. Besides, even a helium content of twice the highest value, namely, 80×10^{-6} c.c./gm., the uranium and thorium content being the same, would raise the age of this hypothetical meteorite to no more than 8,500 million years.

Finally, the similarity of the uranium and thorium content in the six meteorites so far fully analysed justifies an attempt to calculate their ages on the basis of an average value for both these elements. This has been done in the last column of Table 1, assuming the uranium content to be $0{\cdot}7 \times 10^{-8}$ gm./gm. and the thorium content $4{\cdot}0 \times 10^{-8}$ gm./gm. A comparison with the age values calculated on the basis of individual measurements, as given in the last column but one, shows that the figures are not greatly altered. Since it is unlikely that in the near future we shall have an opportunity of measuring the uranium and thorium of the forty-four other meteorites, for the sake of a preliminary rough forecast we have calculated their ages (last column of Table 2), on the assumption that the average activity found for the six iron meteorites in Table 1 is valid for the others as well.

It is not without interest to see how the probable age values are distributed among these fifty meteorites[19], but it should not be forgotten that this column is calculated on the simplifying assumption of constancy of the uranium and thorium content; the last column but one of Table 2, showing the helium content, is, however, based on measurements and, quite apart from the question of age, is worthy of attention. It shows, for example, that some meteorites usually comprised under the same name are clearly distinct. Thus the "Bethany, Goamus" and "Bethany, Amalia" irons, which were recently described as part of the "Gibeon shower"[20], can scarcely all belong to the same fall, since a fine piece of the latter possesses a much higher helium content; and of the four famous "Cape York" meteorites, "Ahnighito" and "Savik" obviously form one group, while "Woman" and "Dog" belong to another—a conclusion not inconsistent with the localities where they have been found[21]. The absence of any detectable helium in iron meteorites of normal chemical composition like "Ahnighito" and "Savik"[22] entitles us to add iron and a few other elements to the list of those[15] which cannot be responsible in beryls for the occurrence of 'surplus helium'.

We hope to discuss these and other minor points when publishing our method and results in greater detail. Our thanks are due to Mr. D. B. Janisch and Dr. E. Glückauf for valuable help in the experiments.

[1] Paneth, F. A., in collaboration with Gehlen, H., Günther, P. L., Urry, Wm. D., and Koeck, W., *Z. Elektrochem.*, **34**, 645 (1928), **36**, 727 (1930); NATURE, **125**, 490 (1930); *Naturwiss.*, **19**, 164 (1931); *Z. physikal. Chem.*, A, **152**, 110, 127 (1931); *ibid.*, Bodenstein-Bd. 145 (1931).

[2] Loc. cit., pp. 158–59.

[3] See Urry, Wm. D., *J. Chem. Phys.*, **4**, 40 (1936).

[4] Glückauf, E., and Paneth, F. A., *Proc. Roy. Soc.*, A, **165**, 229 (1938).

[5] cf. Keevil, N. B., *Amer. J. Sci.*, **236**, 304 (1938).

[6] Du Bridge, L. A., and Brown, H., *Rev. Sci. Instru.*, **4**, 532 (1933); Penick, D. B., *ibid.*, **6**, 115 (1935).

[7] Urry, Wm. D., *J. Chem. Phys.*, **4**, 34 (1936).

[8] Paneth, F. A., *Occas. Not. Roy. Astro. Soc.*, No. 5, 57 (1939).

[9] Nier, O., *Phys. Rev.*, **55**, 150 (1939); Evans, R. D., Hastings, Jane L., and Schumb, W. C., *Field Museum Geolog. Series*, **7**, **71** (1939).

[10] Keevil, N. B., *Amer. J. Sci.*, **237**, 195 (1939); Wickman, F. E., *Sveriges Geologiska Undersökning*, Ser. C, No. 427 (Stockholm, 1939).

[11] Nier, O., *Phys. Rev.*, **55**, 153 (1939).

[12] *Z. phys. Chem.*, A, **152**, 130 (1931).

[13] The individual measurements from which the mean values in Table 1 were calculated are given in the Ph.D. thesis of R. B. Jacobi (London, 1942).

[14] Keevil, N. B., NATURE, **148**, 445 (1941).

[15] Fay, J. W. J., Glückauf, E., and Paneth, F. A., *Proc. Roy. Soc.*, A, **165**, 238 (1938).

[16] Farrington, O. C., *Field Museum Geolog. Series*, **3**, 59 (1907); for rare metals in iron meteorites see Goldschmidt, V. M., *Nach. Gesell. Wiss. Göttingen*, Fachgruppe III, 377 (1932).

[17] See Holmes, A., "The Age of the Earth" (London, 1937).

[18] Bok, Bart J., and Watson, Fletcher G., Report of Committee on Measurement of Geologic Time, 92 (Nat. Research Council, Washington, 1940).

[19] Paneth, F. A., "The Origin of Meteorites" (Halley Lecture, Oxford, 1940).

[20] Spencer, L. J., *Min. Mag.*, **26**, 19 (1941).

[21] Bøggild, O. B., *Saert. Meddel. Grønland*, **74**, 11 (1927).

[22] Goldschmidt, V. M., *Naturwiss.*, **18**, 999 (1930).

HYPOTHESES NON FINGO

By A. E. BELL
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I THINK it was H. E. Armstrong who once remarked, "we are told that the electron does everything but *how* it does anything we are not informed". The criticism is that the word 'electron' is the name of a thing endowed with all the potential properties it is supposed to explain. Much the same criticism was current at one time about the ether, but the electron has perhaps attained more the status of an induction from a wide range of phenomena, while the ether could never have been ranked as more than a hypothetical entity. All the same, there are obvious difficulties in the way of regarding the electron in the light of a scientific realism: its discontinuous and continuous properties seem out of all possible relation with each other; presumably they defeat our mental imagery because of the incommensurability of perceptual space and time—for this seems to be the crux of the distinction between geometrical and causal laws. One is occasionally struck with a suspicion that there are epistemological implications in modern scientific methods. The division of scientific writers into those who adopt a positivist attitude and those who have reacted towards realism marks, maybe, a difference in the broad conceptions of methodology. There are some writers who, as Burtt has remarked, have inverted the relation and have made a metaphysic out of a method. It is not the aim of this short article to attempt to disentangle the philosophical problems involved in the writings of those who have summarized the modern scientific interpretations of phenomena. This has already been done—at least to some extent—by acknowledged leaders in the fields of philosophy and logic. The burden of this article is that there has been, at least from the time of Huygens and Newton, an ultimate divergence in the conceptions of scientific method and in the philosophy tacitly assumed by men of science.

The best setting in which to view Newton's great achievement is against the background of the great speculative systems his work demolished. Newton held that science must keep close to observed facts at all times, must set itself the task of discovering quantitative laws which might be extended by induction. His well-known polemics against hypotheses expressed his distaste for ideas not derived from empirical study of phenomena. Thus the First Book of his "Optics" begins: "My design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove them by reason and experiments. . . ." His attitude was made clearer in a letter to Oldenburg written in July 1672. Here he said ". . . the theory which I propounded, was evinced to me, not by inferring, *it is thus, because it is not otherwise*; . . . but by deriving it from experiments concluding positively and directly. The way therefore to examine it, is, by considering whether the experiments, which I propound, do prove those parts of the theory to which they are applied; or by prosecuting other experiments which the theory may suggest for its examination".

This rebuke to critics like Hooke and Huygens reminds one of his famous general scholium at the end of the "Principia". Here Newton wrote:

"Hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses, *hypotheses non fingo*; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena and afterwards rendered general by induction."

It is clear that it was not the mere multiplication of explanatory principles that Newton opposed. The tendency to reduce these to a minimum is found in other writers. Newtonian physics was based on the concepts of matter and force. The atomists went further and attempted to substitute a process of atomic collision for the operation of forces. As Duhem remarked: "The Principia of Newton had scarcely seen the light of day before it aroused the sarcasms of the atomistic clan grouped around Huygens."[1] In their turn the atomists were frequently assailed by the Cartesians. Papin, a more or less orthodox Cartesian, criticized Huygens for supposing that hardness or impenetrability was the essence of bodies, and to this Huygens replied bluntly that the Cartesian doctrine of extension was absurd. Newton perceived that scientific theories could gain no general acceptance so long as they were made dependent on a particular metaphysic: the opposing schools of thought each considered that the others retained occult properties. Burtt considers that Newton regarded an exact mathematical formulation of natural processes as the most that one can achieve[2]. Newton recognized also that there is a considerable problem in the validity of induction and that there is no absolute certainty in the conclusions of physical science.

Huygens discussed this last point at the beginning of his "Traité de la Lumière". Contrasting classical geometry with seventeenth-century physics, he remarked that "whereas the Geometers prove their Propositions by fixed and incontestable Principles, here the Principles are verified by the conclusions to be drawn from them; the nature of these things not allowing of this being done otherwise. It is always possible to attain thereby to a degree of probability which very often is scarcely less than complete proof." Writing to Tschirnhaus in 1687, Huygens explained that in physical research it is impossible to start "except by starting from experiments . . . then by conceiving certain hypotheses upon which experiments must be made. . . ." One is reminded of Whitehead's remark that ". . . it is the establishment of the procedure of taking the consequences seriously that marks the real discovery of a theory". Both these great men of science followed their own methods incompletely. Newton was not empirical about space and time, and Huygens followed the procedure of taking the consequences seriously only up to the point at which his elegant geometrical constructions were threatened. For him, as for Kepler, there was another important bias: the inclination to believe that mathematical elegance is in some way an index to reality.

Newton's concept of gravity may rightly be regarded as an abstraction and an induction from the accumulated work of Kepler, Galilei and others. Duhem[3] has pointed out that the idea of universal gravitation has an interesting history which goes back to the time of Aristotle and includes reference to da Vinci, Copernicus, Mersenne, Galilei, Gilbert, Kepler, Francis Bacon, Roberval and Borelli. The idea attained the status of a true induction only with Newton, just as that of the atom became an induction with the work of Dalton.

What we call a theory may not be possible of attainment through purely inductive processes. Newton's method of rendering laws general by induction is surely possible only if we employ some general principle of correlation: "If an induction is worth making it may be wrong." Recognizing this, men of science have for a long time been prepared to make pretty shaky inductions; Clerk Maxwell admitted as much in his paper on "The Dynamical Evidence of the Molecular Constitution of Bodies". An attitude of provisional belief is in accordance with Huygens's methodology—and the readiness for the purely provisional in the structure of science is one of the more startling anomalies in modern civilization which in all else demands an impossible finality.

The curious feature of Newton's position is that he would not explicitly allow even guiding hypotheses in more than a vague way. But his work shows that his real objection was to hypothetical *entities* rather than to hypotheses essential to the design of an experiment. His concentration on mathematical *relations* and on that *quantity* which, in Kepler's words, is "prior to the other categories", were in the strongest contrast with the metaphysical and deductive system of Descartes. The space and time of Newton's system were not identical with the space and time of ordinary sense experience: they were abstractions. Huygens was unable to understand Newton's more positivist attitude here, and the realist nature of his own conceptions makes him a convenient starting-point from which to derive the second main stream of scientific thought. Huygens might have accepted the term 'correlate' as equivalent to 'hypothesis' but, in the manner of all atomists of that time, his concepts assumed a garb from perceptual phenomena. For him the atom was a potential phenomenon, as it still is for some modern men of science.

The questions we seem to face then are these: What scientific concepts now employed are to be regarded as inductions from phemomena and not mere hypotheses? Is a scientific realism only to be founded by ignoring Newton's misgivings about hypothetical entities? Are there not to-day the same methodological objections to a process of world-building as applied in the seventeenth century to the Cartesian vortices, namely, its remoteness from empiricism and its employment of fictitious entities? It appears to be impossible to lay down hard and fast rules for the distinction of those concepts which satisfy Newton's demands and those which are purely hypothetical. The history of science suggests that in fact the former often develops out of the latter. Newton's general law of universal gravitation developed out of a particular hypothesis that heavy bodies tend to move towards the centre of the earth. Dalton's atoms were essentially the same as those of the seventeenth-century atomists, but Dalton avoided the error of Gassendi, who multiplied his hypothetical atoms so as to explain the perceptions of all the senses by their means. The atomic theory of Dalton completed a process of induction whereby science gained a principle of quantitative correlation. In the same way, the electron entered modern science. Pure abstractions such as the Newtonian mass, space, time and force appear to be insufficient in themselves, and the scientific interpretation of phenomena not capable of treatment by classical mechanics has proceeded with the use of entities which must possess the qualities of hypotheses. This method Huygens, if not Newton, would have supported.

Science is fortunately an activity in which no one need consider whether his methods have the blessings of the patriarchs or not, but it is interesting to see that in this particular respect the Huygensian attitude confers more freedom than the Newtonian and that, in regard to the broad conception of the place of hypotheses, Huygens was a more profound methodologist than Newton. Newton, on the other hand, showed the clearer grasp of the nature of scientific laws as inductions from which the particular event might be deduced. Whether he would have regarded it as the true function of science to build up a colligative system from which, ultimately, laws might be deduced is another matter. Probably it would appear to him, as it does to certain modern critics, to be a repetition of the errors of Cartesianism though in a more scientific—if not less metaphysical—guise.

In the scientific work of the eighteenth and nineteenth centuries the distinction which presents itself before many others is that of the status of mathematical laws. Following Newton's example, some physicists considered that it was undesirable to go beyond the mathematical formulation of laws. Ampère and Cauchy investigated electric forces mathematically on the Newtonian law of inverse squares; in Great Britain Faraday and Clerk Maxwell studied the effect of the intervening medium and tried to picture a mechanism by which electric forces could be transmitted. The former is the Newtonian, the latter the Huygensian method. The same divergence is clear in the treatment of the concepts of energy and entropy. As mathematical quantities they are doubtless valid abstractions; as fictitious entities existing in their own right, they raise questions of their reality which cannot be answered with final agreement except by those who adopt the same metaphysics. To keep science clear of metaphysical entanglements has long been regarded as of the first importance. It is surely in this light that Newton's famous axiom should be remembered.

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[1] "La Théorie physique", 18 (1906).

[2] "The Metaphysical Foundations of Modern Science", 207 (1932).

[3] Op. cit., 370 *et seq.*

OBITUARIES

Mr. Arthur Grove

The death of Arthur Grove on February 2, in his seventy-eighth year, removes a noted personality from the ranks of the scientifically minded gardeners. The youngest son of Sir George Grove, editor of the "Dictionary of Music and Musicians" and first director of the Royal College of Music, Arthur Stanley Grove was, like his father, an engineer, but early in his life he became attracted to horticulture, as his father had been to music, and he acquired a remarkable collection of plants in his garden near Henley. Stimulated by H. J. Elwes, Grove became interested in the genus Lilium and made this a lifelong study, but though he specialized on lilies he maintained a very wide interest in gardening and was for many years the chief contributor on horticultural subjects to *The Times*. He had an unusual knowledge of good plants and wrote extensively in the gardening Press.

The success of Grove's horticultural skill should be appraised in the light of virus diseases. He took infinite pains with his lilies and achieved remarkable success, but some species repeatedly failed after a few years. In any lily collection there is virus-infected material from which the most carefully raised seedlings may become affected. Grove was baffled and mystified, but never gave in. He attributed his failures to such factors as soil acidity, or alkalinity, or to Botrytis. This was not surprising since plant pathologists could give him no light. Virus diseases of lilies were, indeed, not generally recognized in Great Britain until some years after Ogilvie's work had been published (1928).

The most important work upon which Grove embarked was the preparation of a Supplement to Elwes's "Monograph of the Genus Lilium", and in this he was able to incorporate the results of his unrivalled experience. He had a profound respect for authority, and as an amateur he hesitated to run counter to the writings of professional botanists. It was partly owing to this fine feeling and partly on account of ill-health that he sought expert help when he came to face the critical and much confused species that had to be described for the later parts of the Supplement.

Grove was elected a fellow of the Linnean Society in 1903. He was awarded the Victoria Medal of Honour of the Royal Horticultural Society in 1924, the Veitch Memorial Gold Medal in 1934, and the Gold Medal of the Massachusetts Horticultural Society in 1936. He was, moreover, the first recipient of the Lyttel Lily Cup. He had an attractive literary style and will always be remembered for his great charm of manner and for his whimsical humour.

A. D. C.

Dr. Edward Bureš and Prof. Stefan Kopeć

It has recently been learned that Dr. Edward Bureš, lecturer in organic chemistry at the Charles University, Prague, until the Germans closed the university, has died. He was arrested soon after the outbreak of war and has presumably died in a German concentration camp.

Dr. Bureš had made several contributions to the study of plant chemistry, having described a number of new sterols, for example, raphanisterol from mustard, alkaloids (nymphæine from water-lily) and glycosides.

Prof. Stefan Kopeć, professor of biology in the University of Warsaw, was killed some months ago by the Germans. He was arrested among the 150 Polish persons, every tenth of whom was shot. They had not committed any offence but were taken as hostages after an unsolved incident in which a German was killed.

We regret to announce the following deaths:

Dr. Frank Conrad, assistant chief engineer of the Westinghouse Electric and Manufacturing Company of Pittsburgh, on December 11, aged sixty-seven years.

Prof. P. H. Hanus, emeritus professor of education in Harvard University, on December 14, aged eighty-six years.

Prof. Simon Isaac, formerly professor of internal diseases in the University of Frankfort, an authority on diabetes.

NEWS and VIEWS

Dr. W. Temple: Archbishop of Canterbury

The King has been pleased to nominate the Right Hon. and Most Rev. William Temple, Lord Archbishop of York, Primate of England and Metropolitan, for election by the Dean and Chapter of Canterbury in the place of the Right Hon. the Most Reverend Cosmo Gordon Lang, Lord Archbishop of Canterbury, Primate of All England and Metropolitan. Dr. Temple, who is sixty years of age, has been Archbishop of York since 1929. He was president of the Oxford University Union in 1904, and afterwards a fellow of Queen's College. He was appointed headmaster of Repton School in 1910, where he stayed four years.

Educationists will welcome this appointment, for Dr. Temple has associated himself with social problems and education for many years. He was president of the Workers' Educational Association from 1908 until 1920, and has thus guided it to the great influential position which it now holds in adult and other educational activities throughout the country. His lectures and addresses, especially to undergraduates and other young people, are always listened to with eager attention. In a sermon during the jubilee celebrations of the Victoria University of Manchester, he especially emphasized the need for greater encouragement of research among the staffs of our universities. He is a philosopher of outstanding merit.

The King has also been pleased to nominate the Right Rev. C. F. Garbett, Lord Bishop of Winchester, for election by the Dean and Chapter of York in the place of Dr. Temple. Dr. Garbett has also shown himself deeply interested in social questions.

Dr. Peter Kapitza, F.R.S.: Faraday Medallist

Dr. Peter Kapitza, director of the Institute for Physical Problems of the Academy of Sciences of the U.S.S.R., has been awarded the Faraday Medal of the Institution of Electrical Engineers, "for his notable contributions to science in the generation and utilization of intense magnetic fields". Dr. Kapitza began his scientific career some twenty years ago in the Cavendish Laboratory, Cambridge, where he succeeded in producing magnetic fields much stronger than had hitherto been obtainable. To avoid the difficulty of the heating up of the coil in which the magnetic field was produced, he used a large power for a very short time only; the time was, however, long enough for most magnetic effects to establish themselves, and Kapitza developed many ingenious devices for studying the magnetic properties of matter in such transient fields. With this powerful technique he cleared up various doubtful points about magnetization at high fields and was able to measure the magnetostriction of diamagnetic substances for the first time; a series of researches on the change of electrical resistance of metals in the new region he had opened up also brought to light many interesting new features.

Since magnetic properties generally become much more marked at low temperatures, Kapitza set about the building of a cryogenic laboratory, and here again he brought to bear that rare combination of the talents of the physicist and the engineer which characterizes so much of his work. His work in Cambridge culminated with the development, in the Royal Society Mond Laboratory, of a new method of liquefying helium using the principle of adiabatic expansion. In 1934 he returned to his native country to set up and direct the new Institute for Physical Problems of the Academy of Sciences of the U.S.S.R., where he has continued both his magnetic and his low temperature researches. Recently he has made important discoveries about the remarkable 'superfluid' properties of liquid helium, and he has also developed a much more economical method of liquefying air. For this latter work, which is of considerable industrial as well as scientific interest, he was awarded the Stalin Prize last year.

Rev. T. E. R. Phillips

The University of Oxford is conferring the degree of D.Sc., *honoris causa*, on the Rev. T. E. R. Phillips on February 28. Mr. Phillips's astronomical work began in 1896, while he was curate at Hendford, near Yeovil, where he started systematic work on the planets, especially Jupiter and Mars. In 1916, he was appointed rector of Headley and he set up an observatory in the rectory glebe, where he added an 18-in. reflector (mirror by With) to his other equipment. Mr. Phillips's work on Jupiter has consisted mainly in investigating the surface currents, and the times of the passage of various surface features across the central meridian of the planet are included in this. Other features to which he gave a considerable amount of attention are a 'circulating current' in the southern hemisphere of the planet, the Red Spot, and the South Tropical Disturbance. He has recorded more than a dozen distinct surface-currents, which are well defined and show minor variations of period; incidentally, it may be mentioned that he obtained some 30,000 spot transits. The 8-in. refractor loaned by the Royal Astronomical Society was used for double-star measurements and also for determining the light-curves of long-period variables. The results of his harmonic analysis of the light-curves of about eighty stars were given in his presidential address to the British Astronomical Association in 1916.

Mr. Phillips has been president of Commission 16 of the International Astronomical Union, specially concerned with the physical study of the planets, president during 1914–16 of the British Astronomical Association, and during 1927–29 president of the Royal Astronomical Society. Mr. Phillips is also a meteorologist, and has kept an unbroken daily record of temperatures and rainfall at Headley for twenty-five years. These results and also the results of his harmonic analysis of a number of annual temperature curves in various parts of the British Isles will be published after the War. He is a keen botanist and is specially interested in British and Alpine flora. He is still continuing to use the observatory at Headley, although he retired from active work in the church a year ago, owing to failing health. His many friends hope that he will be long spared to carry on his scientific work.

Home-grown Timbers

The Forest Products Research Laboratory at Princes Risborough has recently issued a third edition (War Emergency Edition) of the "Handbook of Home Grown Timbers" (H.M. Stationery Office, 1941). This has become necessary owing to the greater demand being made on home resources due to a decrease of imports through the restriction of available shipping and an intensified demand. The edition includes information on a number of timbers not in general use, if not entirely unutilizable in peace-time, which can, it is stated, be satisfactorily employed for various useful purposes under war-time conditions. A notable addition, which the wholesale destruction caused by the German bomber has rendered advisable, is information on the fire-resisting properties of most of the species. These valuable data are the result of extensive experimental work carried out at the Laboratory. British grown timbers, we are told, as can be readily imagined, are now being employed in greater quantities and for very exacting purposes, and users are frequently at a loss to know how a particular species may best be utilized for some specified object for which imported timbers have been used in the past. It would be useful and interesting if a list could be made of the actual purposes throughout the country for which home-grown timbers are now being employed.

Genes, Viruses and Proteins

Vol. 9 of the Symposia on Quantitative Biology, published by the Biological Laboratory, Cold Spring Harbor, Long Island, has just appeared. It covers in about 300,000 words the immediate field of "Genes and Chromosomes" indicated by its title, and also a wider range of recent research which can be related to the study of chromosome structure either technically or theoretically. There are thirty-four papers and discussions dealing with optical observations, including the use of the ultra-violet and electron microscopes, X-ray experiments on cell-activity and chromosome breakage, the theory of protein and nucleic acid structure and behaviour, the chemistry and mutations of viruses and genes, and finally the use of the heavy nitrogen isotope in the study of amino-acid exchanges. The series ends by a summary and review by H. J. Muller. This volume is remarkable not only for almost every contribution being new in detail of technique and observation, but also for the whole point of view having arisen from the converging development of genetics, cytology and chemistry during the last ten years.

Electric Cables

Mr. S. W. Melsom, of the Cable Makers' Association, devoted the greater part of his chairman's address to the Transmission Section of the Institution of Electrical Engineers (*J. Inst. Elect. Eng.*, **89**, Pt. 1, No. 13; 1942) to the subject of cable engineering, first making brief reference to the development of solid plastic materials and proceeding to the question of their application to the manufacture of cables. The fierce light thrown on the older dielectrics by competition from the synthetics has revealed the extraordinarily high qualities of rubber and paper, and in the face of this experience new materials cannot be accepted without the fullest assurance of at least as good service with economic advantage. Although chemists have worked hard on the subject, their products have yet to be proved superior or even equal to vulcanized rubber, but doubtless the apparently parallel paths of the rubber and plastics chemists will ultimately be found to converge, with great benefit to both. The address then dealt briefly with very high voltage cables, research and the much discussed question of standardization, and it was closed with an outline of the standing and responsibilities of the engineer in relation to society, suggesting that it is time the engineer took his fair share in responsibility for the control of affairs, for otherwise the most lucrative profession would be that of reaper and not cultivator, a process which, if carried too far, will choke the life out of any industry or nation permitting it.

Heat Requirements of Buildings

A valuable compendium of information has been issued by the Institution of Heating and Ventilating Engineers in a publication entitled "Recommendations for the Computation of Heat Requirements for Buildings" (Pp. iii+41. 1*s*. 9*d*.) This comprises a section of the guide to current practice which was recently compiled for the use of members, and it places at the disposal of all interested in the subject a most comprehensive collection of data strictly in accordance with present-day practice. The information is conveniently grouped in three parts. That on temperature-rise and rates of change gives the recommended values applicable to buildings ranging alphabetically from aircraft sheds to warehouses. The design of heating and ventilating installations has been, in recent years, greatly influenced by legislation affecting factories, and a special section has been devoted to this class of building. Heat transmittance co-efficients for walls, floors and roofs in a variety of materials constitute the second part, which also includes data as to the allowances to be made for height and for conditions of intermittent heating. The third part deals with conductivity data and the calculation of overall coefficients for composite walls, floors and roofs. Included in it is a table of thermal conductivity and resistivity of practically all the proprietary materials used in building construction. Much of the information given has been obtained from such independent sources as the National Physical Laboratory and the U.S. Bureau of Standards, and for the benefit of those unfamiliar with heat-loss calculations as applied to buildings a typical example is included.

Long-Distance Telephony

Voice-frequency signalling and dialling in long-distance telephony forms the subject of a paper read before the Institution of Electrical Engineers by W. G. Radley and E. P. G. Wright. The paper first sets forth the reasons for modern methods of signalling and dialling over long-distance telephone circuits and for preferring the use of voice-frequency methods for these purposes. An outline is given of the technical problems involved in the design of voice-frequency signalling systems and the author deals with operating requirements as well as with receiver and system design. Reference is also made to the recommendations of the International Consultative Committee on Long-Distance Telephony regarding means of avoiding interference between different signalling systems on international connexions and a forecast is given of the future development of signalling and dialling over long-distance telephone circuits. An interesting table is included which compares the various long-distance signalling systems in great detail.

The Yellow Fever Situation

According to the *Journal of the American Medical Association* of January 10, owing to perfection of control methods initiated by Gorgas and Oswaldo

Cruz, there have been no reports of yellow fever in Brazil or in the whole western hemisphere during 1941 or in the previous three years. Attention now centres on jungle yellow fever, which differs from urban yellow fever in that it is not transmitted by *Aedes œgypti.* Risk of yellow fever, however, will remain so long as the jungle type persists. It is no longer enough to accept clinical opinion, however experienced, for the diagnosis of yellow fever, but laboratory information by viscerotomy and protection tests is necessary. Vaccination has been carried out on a large scale with satisfactory results. The International Health Board of the Rockefeller Foundation continues to co-operate in the epidemiological and laboratory studies of the disease and in the preparation of vaccine.

Seismology in the South-western Pacific

During the past year, 1941, a new teleseismic station was established at Auckland, New Zealand. The station is equipped with a Milne-Shaw seismograph, and accurate time is maintained on the records. It is administered by the Dominion Observatory, Wellington (acting director, Mr. R. C. Hayes), as part of the New Zealand seismological service. The instrument was established with the co-operation of the Auckland Institute and Museum, and is operated by members of the Museum staff. This new station is proving of great value in the recording of earthquakes, not only in the New Zealand region, but also in the south-western Pacific generally.

Rockefeller Medical Studentships

The Rockefeller Foundation is again offering twenty-five studentships to enable men or women to take part of their clinical courses at medical schools in the United States and Canada. The offer is made primarily to help students in schools which have suffered in consequence of enemy action, but suitable applications from all medical schools in England, Wales, Scotland and Northern Ireland will be welcomed. The studentships, which are tenable for two years, will cover all tuition fees, maintenance, etc., but not the cost of travel to and from America. Students must return to Great Britain in order to take their final examination. Application forms may be obtained from the Dean of the Medical Faculty or School and must be sent in only by the Dean not later than April 25.

Journal of the Franklin Institute

In spite of the difficulties of Atlantic transport, copies of the principal American scientific journals continue to reach us. The *Journal of the Franklin Institute* is outstanding from those of general interest and the December 1941 number, including the index to Vol. 232, maintains the usual high standard and variety of interest. A paper by Carl van Doren on Franklin himself deals with the remarkable American after whom the Institute is named. His qualities as man of science, diplomatist, statesman, business man, economist, printer, humorist and wit, writer and sage are all surveyed. Two technical papers are followed by notes from the National Bureau of Standards and the Biochemical Research Foundation, and a lively group of notes on current topics and book reviews. The *Journal* is published monthly from the Franklin Institute in Philadelphia.

Night Sky in March

The length of day and night will reach equality when the sun enters the vernal equinox on March 21d. 6h. U.T. The moon is full on March 3d. 0h. 20m. and on March 2–3 there will be a total eclipse of the moon, visible at Greenwich. The circumstances of the eclipse are as follows:

Moon enters penumbra ...	March	2d.	21h.	27·6m.
,, ,, umbra		2	22	31·3
Total eclipse begins		2	23	33·2
Middle of eclipse		3	00	21·5
Total eclipse ends		3	01	09·8
Moon leaves umbra		3	02	11·5
Moon leaves penumbra ...		3	03	15·0

The moon is new on March 16d. 23h. 50m. and there will be a partial eclipse of the sun on March 16–17, invisible at Greenwich, visible only in the South Pacific and Antarctic Oceans.

The occultations of the planets by the moon are as follows: Venus on March 13d. 15h., Venus 2° N.; Mercury on March 14d. 22h., Mercury 3° S.; Saturn on March 21d. 15h., Saturn 3° N.; Mars on March 22d. 20h., Mars 7° N.; Jupiter on March 23d. 08h., Jupiter 5° N.; Mars and Neptune will be in conjunction on March 2d. 7h., Mars being 1·6° N. Mars, Jupiter and Saturn are well placed for observation during the month. Venus is a morning star, and in the middle of the month rises at 4h. 30m. Among the occultations of stars not fainter than mag. 4, the following may be noted: March 4d. 1h. 22·2m., β Virginis; March 22d. 18h. 41·3m., θ^1 Tauri; March 22d. 18h. 47·8m., θ^2 Tauri.

Announcements

Lieut.-General A. G. L. McNaughton has been elected an honorary member of the Institution of Electrical Engineers. This distinction has been conferred upon General McNaughton, who was until recently commander of Canadian troops in Great Britain, in appreciation of the outstanding services rendered by him to promote the practical application of science to industry, in which respect his work on high-voltage research during his presidency of the Canadian National Research Council has been specially notable.

Colonel S. J. Thompson, governing director of Messrs. John Thompson, Ltd., Wolverhampton (water tube boilers, motor frame pressings, etc.), has been elected president of the Institution of Mechanical Engineers, in succession to Mr. W. A. Stanier, chief mechanical engineer of the London Midland and Scottish Railway, whose term of office has expired.

John Scott Medals and Premiums of the American Philosophical Society have been awarded to Major Edwin H. Armstrong, professor of electrical engineering, Columbia University, for his work in frequency modulation in radio; and Robert R. Williams, chemical director, Bell Telephone Laboratories, for his work on thiamin (vitamin B_1).

Arrangements have been completed for the publication of a volume of "Essays in Anthropology" to be presented to Rai Bahadur Sarat Chandra Roy, the distinguished Indian worker in this field. A limited edition is being printed. Orders for copies, with remittance (*Rs.* 12), should be sent to Dr. D. N. Majumdar, Anthropology Laboratory, University of Lucknow.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Neutralization of Sulphonamide Inhibition of Yeast Growth by *p*-Aminobenzoic Acid

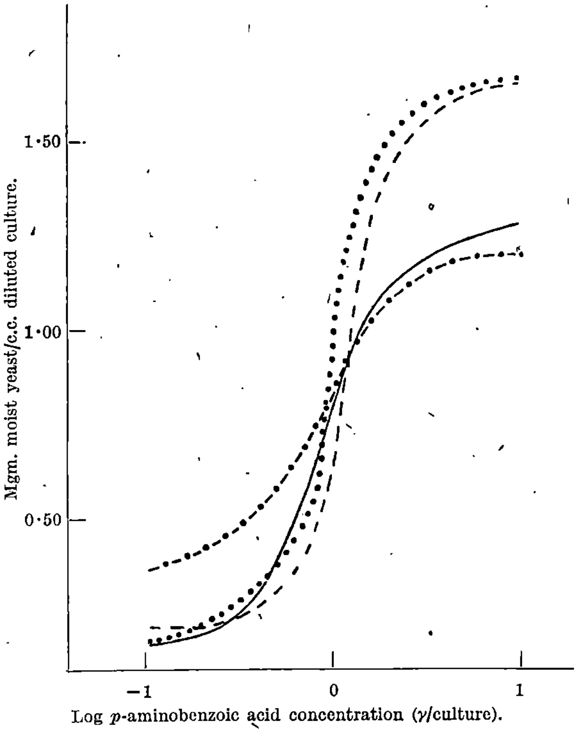
From the many theories concerning the mode of action of sulphonamides, one by Fildes[1] has recently emerged which, because of the volume of evidence brought forth in its support, is now considered the most logical explanation of sulphonamide bacteriostasis. Fildes has suggested that inhibitors of microbial growth are effective as a result of interference with an "essential metabolite", a substance which he defined as having an essential part in the chain of synthesis necessary for growth. Woods[2] was able to show that *p*-aminobenzoic acid nullified the growth-inhibitory action of sulphanilamide for a number of bacteria. Studies in this laboratory[3] have confirmed Woods's original observations. It was found that the *in vitro* bacteriostatic effect of sulphanilamide, sulphapyridine, and sulphathiazole on streptococci, pneumococci, and staphylococci respectively was neutralized by *p*-aminobenzoic acid. Dimond[4] has recently reported similar growth-inhibition of the fungus *Trichophyton purpureum* by sulphanilamide and neutralization of this inhibition by *p*-aminobenzoic acid. The present report describes the application of Woods's findings to yeast growth and suggests the importance of *p*-aminobenzoic acid in yeast metabolism.

The test organism, *Saccharomyces cerevisiæ* No. 139, was cultured in the synthetic basal medium of Snell, Eakin and Williams[5], made complete by the addition of sufficient biotin to support half-maximum growth. The complete basal medium in 10 c.c. quantities was inoculated with 0·06 mgm. moist yeast, and incubated for sixteen hours at 30° C. Growth was measured with a photo-electric nephelometer.

The inhibitory effect of sulphanilamide, sulphapyridine, sulphaguanidine and sulphathiazole was determined by adding the sulphonamide under test to flasks of inoculated medium and incubating as above. Complete inhibition of yeast growth was obtained with the following amounts of sulphonamides: sulphanilamide, 2·0 mgm.; sulphapyridine (sodium salt), 2·5 mgm.; sulphaguanidine, 2·0 mgm.; sulphathiazole, 1 mgm.

The neutralizing effect of *p*-aminobenzoic acid on yeast growth inhibition was demonstrated by the addition of varying amounts of *p*-aminobenzoic acid to flasks of inoculated media, each containing that amount of sulphonamide necessary for complete inhibition of growth. The results are illustrated in the accompanying figure, in which the quantity of yeast growth, plotted against *p*-aminobenzoic acid, was, in general, similar for all the sulphonamides tested. In all cases, the variation of *p*-aminobenzoic acid concentration from 0·1 to 10·0 micrograms per culture resulted in complete range of neutralization.

Since the basal medium used in these experiments was synthetic in composition and did not contain *p*-aminobenzoic acid, it was of interest to determine whether or not this substance was synthesized. A sixteen-hour culture in the complete basal medium as described above was autoclaved to effect hydrolysis and centrifuged to remove cellular debris. The supernatant was assayed for *p*-aminobenzoic acid content by comparing its neutralizing effect on sulphathiazole with that of a reference standard set of *p*-aminobenzoic acid dilutions. It was found that such supernatants contained a substance which neutralized the inhibitory effect of sulphathiazole. When measured in this way, 10-c.c. cultures contained a neutralizing substance equivalent to approximately 1·5 micrograms of *p*-aminobenzoic acid.



NEUTRALIZATION OF SULPHONAMIDE INHIBITION OF YEAST GROWTH BY *p*-AMINOBENZOIC ACID.

— · — · —, sulphapyridine (Na), 2·5 mgm./culture.
· · · · · ·, sulphaguanidine, 2·0 mgm./culture.
— — — —, sulphanilamide, 2·0 mgm./culture.
————, sulphathiazole, 1·0 mgm./culture.

On the basis of the foregoing evidence, the following conclusions seem warranted:

Yeast growth is completely inhibited by sulphonamides. This inhibition is neutralized by *p*-aminobenzoic acid.

Yeast synthesizes either *p*-aminobenzoic acid or its biologically active equivalent. *p*-Aminobenzoic acid may, therefore, be important in yeast metabolism, possibly as the "essential metabolite" of Fildes.

Maurice Landy.
Dorothy M. Dicken.

Research Laboratories,
S.M.A. Corporation,
Chagrin Falls, Ohio.
Jan. 5.

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[1] Fildes, *Lancet*, 1, 955 (1940).

[2] Woods, *Brit. J. Exp. Path.*, **21**, 74 (1940).

[3] Landy and Wyeno, *Proc. Soc. Exp. Biol. and Med.*, **46**, 59 (1941).

[4] Dimond, *Science*, **94**, 420 (1941).

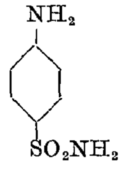
[5] Snell, Eakin and Williams, *J. Amer. Chem. Soc.*, **62**, 175 (1940).

Relative Acidity and Basicity of Sulphanilamide and *p*-Aminobenzoic Acid

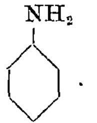
SINCE no determination of the relative acidic or basic dissociation constants of sulphanilamide appears to have been published, this drug was potentiometrically titrated against *N*/1 hydrochloric acid followed by *N*/1 sodium hydroxide. *p*-Aminobenzoic acid and *p*-aminophenylacetic acid were treated similarly for purposes of comparison. In each case, a solution of freshly recrystallized, pure material (0·0005 gm. mol. in 20 ml. of water) was titrated in a beaker fitted with a stirrer, glass electrode and potassium chloride agar bridge connected to a calomel half-cell and a Leeds and Northrup universal *p*H potentiometer assembly. The results are shown in the accompanying figure and the derived (uncorrected) dissociation constants are given in the table.

Substance	*K* (base)	*K* (acid)
Sulphanilamide	$1 \cdot 6 \times 10^{-12}$	$6 \cdot 3 \times 10^{-11}$
p-Aminobenzoic acid	$3 \cdot 1 \times 10^{-12}$	$1 \cdot 5 \times 10^{-5}$
p-Aminophenylacetic acid ...	$3 \cdot 1 \times 10^{-11}$	$6 \cdot 3 \times 10^{-6}$

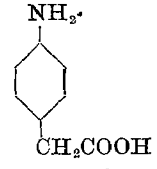
Woods[1] showed *in vitro* that *p*-aminobenzoic acid can counteract the antibacterial action of sulphanilamide; Selbie[2] found that *p*-aminobenzoic acid inhibited the curative action of sulphanilamide in the streptococcal infection of mice; Findlay[3] found that *p*-aminobenzoic acid interfered with the curative action of sulphanilamide on mice infected with the virus of lymphogranuloma; Rubbo and Gillespie[4] first showed that *p*-aminobenzoic acid was a growth factor for a bacterium (*Clostridium acetobutylicum* (W.)) and that its activity could be neutralized by a large excess of sulphanilamide; finally, Lipmann[5] reported that sulphanilamide inhibited the oxidation of *p*-aminobenzoic acid by peroxidase and hydrogen peroxide. There is thus good support for Fildes's hypothesis[6] that sulphanilamide acts biologically by competing against the essential metabolite, *p*-aminobenzoic acid, for the possession of particular groups (receptors) in enzyme systems. Fildes further states that such an inhibitor as sulphanilamide requires sufficient chemical similarity to the essential metabolite in order to fit the same enzyme system and yet must differ sufficiently to be devoid of metabolic activity.



Sulphanilamide

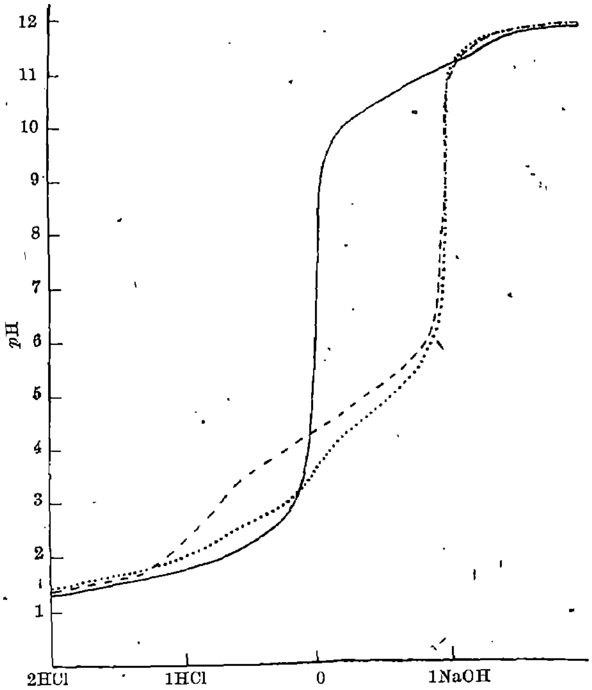


p-Aminobenzoic acid



p-Aminophenyl-acetic acid

Sulphanilamide answers to this description since, as the above formulæ show, it has a certain steric similarity to *p*-aminobenzoic acid and resembles it in forming salts with strong acids and strong bases. As a result of the potentiometric titrations, this comparison can now be put on a more quantitative basis. Sulphanilamide and *p*-aminobenzoic acid are found to be bases of approximately the same strength, but sulphanilamide is about a million times weaker as an acid. This weak acidity of sulphanilamide is probably unessential as is shown by the high efficiency of 4 : 4′-diaminodiphenylsulphone. On the other hand, the basicity seems highly significant, being common to both substances. The biological importance of such a feeble basicity (K base $= 10^{-12}$) may be connected with chemical reactions other than salt formation, possibly with the formation of hydroxylamino compounds. At least, it is known that stronger, simple aromatic bases such as aniline (200 times) and *p*-aminophenol (2,000 times stronger than sulphanilamide) do not possess sulphanilamide-like activity.



POTENTIOMETRIC TITRATION CURVES AT 20° C.
...... *p*-aminobenzoic acid;
—— sulphanilamide;
- - - *p*-aminophenylacetic acid.

p-Aminophenylacetic acid was included in these titrations since Rubbo *et al.*[7] showed that it is ten times as potent a growth factor for *Cl. acetobutylicum* (W.) as *p*-aminobenzoic acid and, unlike the latter, possesses no anti-sulphanilamide activity[8]. The titrations show that both growth factors have approximately the same strength as acids, but *p*-aminophenylacetic acid is ten times as strong a base. While it would be premature to draw conclusions from these results, the further study of growth-factor chemistry along these lines seems indicated.

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Nov. 21.

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[1] Woods, D. D., *Brit. J. Exper. Path.*, **21**, 74 (1940).

[2] Selbie, F. R., *Brit. J. Exper. Path.*, **21**, 90 (1940).

[3] Findlay, G. M., *Brit. J. Exper. Path.*, **21**, 356 (1940).

[4] Rubbo, S. D., and Gillespie, J. M., NATURE, **146**, 838 (1940).

[5] Lipmann, F., *J. Biol. Chem.*, **139**, 977 (1941).

[6] Fildes, P., *Lancet*, **1**, 955 (1940).

[7] Rubbo, S. D., Maxwell, M., Fairbridge, R. A., and Gillespie, J. M., *Aust. J. Exper. Biol. Med. Sci.*, **19**, 185 (1941).

[8] Rubbo, S. D., and Gillespie, J. M., *Lancet*, in the press.

Genetic Nature of Self- and Cross-Incompatibility in Potatoes*

INVESTIGATIONS on the various types of sterility in potatoes were begun in 1936 and in the present note the genetic nature of sterility resulting from physiological incompatibility is reported.

Although a great amount of work on self- and cross-incompatibility has been done in a variety of crops, very little information on the subject is available on potatoes. Stout and Clark[1] and Clark[2] mention the occurrence of self- and cross-incompatibility in two species, *Solanum chacoense* and *S. Jamesii*.

Our investigations reveal that many of the diploid ($2n = 24$) species, including *S. aracc-papa*, *S. Caldasii*, *S. chacoense*, *S. Jamesii* and *S. subtilius*, are characterized by a high degree of physiological self-incompatibility while several tetraploid ($2n = 48$) species and the hexaploid ($2n = 72$) species *S. demissum* are self-compatible.

The genetic nature of self- and cross-incompatibility has been worked out for *S. Caldasii* and *S. subtilius*.

S. Caldasii : Sixteen varieties of this species were intercrossed in all possible combinations. These gave five intra-sterile but inter-fertile classes with 1, 2, 4, 4 and 5 varieties in each of the classes respectively.

S. subtilius : Only one variety was available. This was cross-compatible with all the five classes mentioned above and therefore represented the sixth class.

Four families derived from crosses between representative plants of the six groups mentioned above were raised, and plants in each family inter-crossed among themselves and analysed for the existence of intra-sterile and inter-fertile groups.

1. Family No. C–77—*S. subtilius* var. V_1 × *S. Caldasii* var. M_{05}.

Twenty-two plants when inter-crossed gave two (*A* and *B*) inter-fertile but intra-sterile classes. The male parent associated itself with group *A* while the female parent (group *C*) was cross-compatible with both the groups.

2. Family No. D–27—*S. Caldasii* var. 012 × *S. Caldasii* var. 07.

Seventeen plants when inter-crossed gave results similar to those obtained in cross No. 1. Class *E* included the male parent while class *F*, the female parent, was cross-compatible with both *D* and *E* classes.

3. Family No. D–25—*S. Caldasii* var. 04 × *S. Caldasii* var. 01.

Twenty-two plants when inter-crossed gave four almost equal-sized intra-sterile but inter-fertile groups. Both *K* and *L*, the male and female parents respectively, were cross-compatible with all the four groups, *G*, *H*, *I* and *J*.

4. Family No. *D*–26—*S. Caldasii* var. 07 × *S. Caldasii* var. 01.

The behaviour of this cross was similar to cross No. 3. The four intra-sterile inter-fertile groups, *M*, *O* and *P* were compatible with the two parental groups *Q* and *R*.

The four crosses above gave in all eighteen groups of plants, represented by the letters *A* to *R*. Examination of the data showed that certain groups contained genotypically similar plants with regard to self-sterility factors. To confirm this conclusion and to determine the major groups, two plants from each of the eighteen groups were selected and the thirty-six plants were inter-crossed in all possible combinations. The results so obtained are given in the accompanying diagram, which clearly brings out the relationship between the various groups. The two plants under each group behaved similarly with regard to compatibility relationship. The eighteen original groups of plants, it will be seen, are composed of only eight major groups.

The results outlined above show that self- and cross-incompatibility in *S. Caldasii* and *S. subtilius* are distinctly inherited characters.

Constitution:	s^1s^2				s^1s^3	s^1s^4			s^1s^5		s^2s^3	s^2s^4			s^2s^5		s^4s^5	
Groups	A	F	H	O	C	D	G	P	L	Q	B	E	K	R	J	M	I	N
A	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
F	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
H	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
O	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+
C	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+
D	+	+	+	+	+	−	−	−	+	+	+	+	+	+	+	+	+	+
G	+	+	+	+	+	−	−	−	+	+	+	+	+	+	+	+	+	+
P	+	+	+	+	+	−	−	−	+	+	+	+	+	+	+	+	+	+
L	+	+	+	+	+	+	+	+	−	−	+	+	+	+	+	+	+	+
Q	+	+	+	+	+	+	+	+	−	−	+	+	+	+	+	+	+	+
B	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	+
E	+	+	+	+	+	+	+	+	+	+	+	−	−	−	+	+	+	+
K	+		+		+		+		+	+		−	−	−	+		+	
R	+	+	+	+	+	+	+	+	+	+	+	−	−	−	+	+	+	+
J	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	+	+
M	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	+	+
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−
N	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−

DIAGRAM SHOWING THE RELATIONSHIP OF THE EIGHTEEN INTRA-STERILE GROUPS.

—, cross- and self-incompatible combination; +, cross-compatible combination.

Detailed examination of the data available shows that there are at least five sterility factors S^1, S^2, S^3, S^4 and S^5 which, operating in various combinations, determine self- and cross-compatibility. The genetic composition of the eight major groups of plants shown in the diagram has been established and is given in the diagram. The mode of action of these factors is in conformity with the oppositional factor hypothesis developed by East and Mangelsdorf[3]. Here it is of interest to note that the five '*S*' factors can give only ten possible combinations out of which eight have been established, and the representative plants are being maintained as 'testers' for further work. Suitable crosses have been made to secure the remaining two combinations, S^3S^4 and S^3S^5.

There is evidence of a sixth '*S*' factor, but the data so far available are not sufficient to establish its existence positively. Some varieties of *S. chacoense* appear to possess in addition to '*S*' factors a fertility factor '*F*'. Investigations in these directions are in progress.

It may be pointed out here that *S. subtilius* and *S. Caldasii*, which resemble each other closely in their floral and vegetative characters and in their reactions to short-day conditions, also possess '*S*' factors in the same allelic series. Therefore there does not appear to be any reason to regard them as separate species.

The investigation reported above forms part of the work of the Potato Breeding Scheme for Northern India financed by the Imperial Council of Agricultural Research the assistance of which is gratefully

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* Slightly abridged.

acknowledged. We are indebted to Dr. S. Ramanujam, second economic botanist at this Institute, for valuable advice and suggestions.

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Oct. 28.

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[1] Stout, A. B., and Clark, C. F., *Bull. U.S. Dept. Agric.*, 1159, 1–32 (1924).

[2] Clark, C. F., *Mem. Hort. Soc.*, N.Y., 3, 289 (1927).

[3] East, E. M., and Mangelsdorf, A. T., *Proc. U.S. Nat. Acad. Sci.*, 9, 166 (1925).

Colour Measurement

Messrs. Smith, Guild and Donaldson's fears[1] of misconceptions were not at all justified. My letter[2] directed attention to certain *general* aspects of the physics of colour measurement. Emphasis was upon the need for knowledge in order to provide, for the concretest possible colour problems, the fullest possible analysis. Technical developments were a secondary consideration. I have not committed the elementary errors (*a*) of confusing the C.I.E. standards with the procedure, or (*b*) of thinking that errors in $\chi_{\text{C.I.E.}}$ values are possible owing to the procedure followed in the original experiments. The C.I.E. standards as such are exact. Also, I have no difficulties with the C.I.E. standard observer. All my references to the C.I.E. colorimetric system involved purely its place in a general physics of colour. The C.I.E. system of colorimetric standards, physical constants and agreed procedure is a convention which I do not regard as open to question, or as involved radically in this discussion. I do not question Messrs. Smith, Guild and Donaldson's appraisement of the merits of the C.I.E. system and have expressed parallel sentiments recently[3].

It would appear that Messrs. Smith, Guild and Donaldson hold the C.I.E. system to be capable of fulfilling the conditions of physical measurement for any field size, field brightness, etc. With this I cannot agree. The original measurements of Guild and Wright only provide evidence for the use of the C.I.E. system in the conditions under which such measurements were obtained. Ives[4], in referring to this same question of validity in relation to field size, brightness and the "visibility function", which is a very essential part of the C.I.E. data, says: "The International Illumination Commission in adopting a certain luminosity curve for the equal energy spectrum has in effect committed itself to the photometric conditions under which this curve was made and holds . . . and has authorised the use of a small photometric field." Guild[5], after the institution of the C.I.E. colorimetric system, has stated "that the colour-matching relations of stimuli can be expressed quantitatively in terms of two independent variables" [for example, x and y, in $x+y+z=1$] "has to be qualified by restricting it to a range of conditions within which the visibility curve is known to be constant.". This clearly is an application of the fact that, although a convention may be created at will, its physical validity is limited to the range of conditions within which it is known to apply. Its present bearing is obvious.

That on passing from foveal to peripheral vision matches of colour vary is clearly stated by Abney[6], Hering[7], von Helmholtz[8] and others. Such differences as these are not to be ascribed merely to peculiarities distinguishing the properties of the observer from a statistical average, as might be concluded from the letter of Messrs. Smith, Guild and Donaldson, but to common differences between the colorimetric properties of foveal and extra-foveal vision. Some consequences of this have in fact been described by Dr. Guild[9] in the words: "A large photometric field which averages the properties of a large region of the retina will in general give greater weight to radiation of shorter wavelength than a smaller field not extending so far beyond the fovea." This effect, which may be considerable, may readily be demonstrated and probably accounts for the phenomenon, described by Harrison[10], having an important practical bearing, namely, that a standard white equal in brightness to a comparatively bluish white when viewed by foveal vision, appears less bright than the same bluish white when viewed with a large photometric field. Thus, the essential condition to be complied with by a physical measurement, namely, that it shall correlate physical quantities with magnitudes in serial order, and not assign two magnitudes to the same quantity, or vice versa, is not necessarily still complied with by the C.I.E. system when the field size is extended. The adaptation of the C.I.E. colorimetric system to large fields is therefore only possible by virtue of a convention embodying some arbitrary and artificial restriction.

Let me say, apropos of Messrs. Smith, Guild and Donaldson's reference to the large colorimetric field used with a spectrophotometric match, as a technical device to aid C.I.E. colour measurement, that I intend these remarks to be no criticism of the use of this, provided only that proper qualifications as to validity are accepted; but it may be as well to point out that the spectrophotometric restriction, which is implied in their reference in this connexion to a "physically uniform field", reduces Newton's law, upon which colorimetry is based, to a tautology, and destroys its essential independence of spectrophotometric distribution. Even in such circumstances, that is, with a physically uniform field, differences in appearance in different parts of the field will sometimes be perceived, as when, for example, the radiation comprises two spectrum bands (their half-width may be at least 500 A.) centred approximately about wave-lengths 0·49 μ and 0·62 μ. In this case, although the major part of the field appears white, the central region of the field of vision appears pink, due to the effect of the macula lutea. In ordinary circumstances, vision synthesizes the whole impression received, into a visually homogeneous complex corresponding[2] to χ_N. That "regional variation of retinal properties is formally irrelevant to appearances in an extended field", as stated by Messrs. Smith, Guild and Donaldson, results in such cases in two differing appearances having simultaneously the same colorimetric specification. It is clear, however, that when conditions are not restricted to the sphere of significance of the quantities measured, "we can obtain a colour and brightness match under any conditions whatever and reduce the results to the *form* of a colorimetric relation without realising that the figures so obtained are meaningless"[5]. It will be clear from the foregoing that for conventional measurement to be physical measurement it must follow the *ABC* of physical science, namely, (*A*) experiment, (*B*) hypothesis, (*C*) verification, (*D*) standardization and measurement.

The statements of Messrs. Smith, Guild and Donaldson concerning accuracy may be accounted for by my statements being understood too narrowly, as applying to the C.I.E. system, instead of to the physics of the subject. Other points arise from Messrs. Smith, Guild and Donaldson's letter, which cannot be considered here out of considerations of space, but I hope it will be perceived that there remains material for investigation and grounds for new and broader conceptions in this subject.

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[1] Smith, Guild and Donaldson, NATURE, 149, 76 (1942).

[2] Perry, NATURE, 148, 691 (1941).

[3] Perry, *Proc. Phys. Soc.*, 54, 9 (1942).

[4] Ives, *Proc. Opt. Conv.*, 143 (1926).

[5] Guild, "Discussion on Vision", 83/4 (London, 1932).

[6] Abney, "Colour Measurement and Mixture" (London, 1891).

[7] Hering, *Arch. f. ges. Physiol.*, 60, 533 (1895).

[8] von Helmholtz, "Handb. d. physiol. Optik", 373 (1896).

[9] Guild, *Proc. Opt. Conv.*, 94 (1926).

[10] Harrison, *Proc. Phys. Soc.* (in the press).

The Electromagnetic Mental Picture

RECENT text-books[1] reflect a certain uneasiness concerning the presentation to students of 'engineering' electricity. Some teachers advocate classical field theory alone, others introduce the electron theory, linking it with field theory at every stage. But the awkward unsolved problems of theory cannot then be avoided; thus, the two writers cited take quite different views concerning the induction of a current by motion of conductor and magnet respectively. These theoretical problems do not concern the designer and inventor, who needs above all a mental picture which will give a correct qualitative prediction of the functioning of any proposed apparatus. The formulæ which he will then apply for calculation may, as we know, be derived from various quite different hypotheses. Such differences as appear capable of deciding between different hypotheses are beyond the limits of error of our experimental powers[2].

Useful as the field picture undoubtedly is, the literature from the time of Faraday to the present day affords numerous examples of futile experiments and discussions based upon a too literal interpretation of it. Anyone can test the fact that it may mislead the most experienced. I have asked more than a dozen highly skilled physicists and radio research men whether the inductance of a straight wire is greater or less than that of the same wire bent into a circle. Without exception they answered wrongly. The only correct answer so far came from a young chemist. In the following cases the field picture as usually stated seems to be inadequate. If a toroid solenoid is placed with its plane at right angles to that of a horseshoe magnet and with a few of its turns in the pole gap of the magnet, the field picture seems to call for a torque on the toroid, but none on the magnet. Again, if a horseshoe magnet be rotated when placed so as to send flux through a few turns only of a short-circuited toroid, the field theory seems to call for an alternating current in the toroid, with no reactive torque on the magnet. It is interesting to consider also the effect of removing to a distance that part of the toroid which is *outside* the field of the magnet.

Radio is now perhaps the most important, and certainly the most progressive branch of electrical engineering, and here the particle picture is essential in vacuum tube discussion. Why not base the consideration of capacity, inductance and transmission upon it as well? Historical piety should not lead us to burden the beginner's mind with the difficulties and artificialities of the magnetic field picture, evidenced in the treatment of open and frame aerials, or of the fields near a transmitting antenna. If radio phenomena are dealt with on the lines given in my letter of August 16, 1941, the resulting mental picture of phenomena is at east as penetrating and illuminating as that given by field theory.

H. STAFFORD HATFIELD.

Thatch End,
Hildersham, Cambs.
Jan. 24.

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[1] e.g., Zeleny, "Elements of Electricity and Magnetism" (New York, 1935); Cullwick, "Fundamentals of Electricity and Magnetism" (Cambridge, 1939).

[2] O'Rahilly, "Electromagnetics: a Discussion of Fundamentals" (London and Cork, 1938).

Occurrence of Ctenodrilus in the Pacific

THE annelid Ctenodrilus does not seem to have been recorded outside Europe, so that its occurrence in quantity at Ladysmith Harbour, on the east coast of Vancouver Island, B.C., is perhaps worthy of note. A small artificial lagoon was constructed there last summer in connexion with work on oyster culture in which the temperature of the water rose abnormally high. Material, collected with a towed plankton net in this lagoon in August contained large numbers of *Ctenodrilus serratus* (O. Schmidt) which has probably been swept off the eel-grass and other vegetation growing there.

Ctenodrilus is of some special interest because divergent views have been held from time to time as to its taxonomic position. It is now generally regarded as a polychæte and placed among the Cirratulidæ.

C. BERKELEY.

Marine Biological Station,
Nanaimo, B.C.
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British Zoologist Prisoners of War in Europe

A FELLOW of this Society resident in a country at present under German control has generously offered to help British zoologists and entomologists who are prisoners of war in Germany or the enemy-occupied countries of Europe by correspondence and the loan of literature and such other means as are within his power.

The Royal Entomological Society of London is in regular communication with this fellow and invites information regarding zoologists and entomologists known to be prisoners of war in Europe. Exact details of name and address are the only essentials required, and it is emphasized that the Society has no means of transmitting messages to prisoners except through the service organized by the British Red Cross. Information may be sent to the Registrar, Royal Entomological Society of London, 41 Queen's Gate, London, S.W.7.

FRANCIS J. GRIFFIN
(Registrar).

Royal Entomological Society of London.

RESEARCH ITEMS

Morphology of a Cicada

J. W. EVANS has recently described the structure of the anomalous cicada *Tettigarcta* White. Little has been known of this insect, which betrays certain primitive features and is widely divergent from all other Cicadidæ (*Papers and Proc. Roy. Soc. Tasmania* for 1940; pub. 1941). Most of the specimens of the species *T. tomentosa* were taken at an altitude of 2,500 ft. during the Tasmanian winter (May and June), being attracted to lights at night. During the day the insect shelters beneath bark. Among various features the absence of tympanal organs in both sexes is notable. Tymbals, however, are present with their muscles slightly less developed in the female than in the male. It is conjectured that Tettigarcta is a descendant from an early cicadan stock that possessed well-developed sound-producing organs and sound-detecting organs in both sexes. For some reason, possibly associated with its nocturnal habits and cold environment, for other cicadas are essentially scent-loving insects, it has ceased to produce sound. Among other structural features the nymphs of Tettigarcta have nine segments to the antennæ—a higher number than is found in other cicadas. The venation is exceptionally complete with a separate costal vein in the hind wing. The male genitalia have a true ædeagus, also there is an unusual development of the basal plates, and harpagones are present.

Origins of Garden Roses

THE continuous blooming of garden roses must be a matter of wonder to those who compare it with the limited flowering of wild types. C. C. Hurst shows (*J. Roy. Hort. Soc.*, 66, Pts. 7 and 8, July and August, 1941) that this fortunate gene was introduced early in the nineteenth century from the China rose, *Rosa Chinensis*. It was first crossed with the Tea rose, *R. gigantea*, to form pink, blush and yellow stocks. The Pink China crossed with *R. moschata* gave the Noisette rose and when separately combined with the Pink Autumn Damask, *R. rubra*, it gave the Bourbon Rose. Hybrid Perpetuals were obtained by crossing hybrid China forms with Bourbons, Noisettes, and an English stock named after the Duchess of Portland. Hybrid Tea roses, occupying the throne of garden beauty, resulted from a fusion of Hybrid Perpetuals and Teas. The twentieth century brought the introduction of *R. lutea* from Persia, and with it the Pernet rose (Hybrid Perpetual × Austrian Briar, *R. lutea*). A wealth of historical detail is combined with genetical information in the papers under review.

A New Strain of Potato Virus

SINCE the discovery that interveinal mosaic and crinkle virus diseases of the potato are caused by mixtures of viruses, much work has been devoted to the isolation and identification of the constituents. Phyllis M. Clinch has recently elucidated one of the remaining problems (*Sci. Proc. Roy. Dub. Soc.*, 22, No. 46, 435–45, December, 1941). One source of interveinal mosaic, which is a mixture of viruses X and F, was found to include also a strain of top-necrosis. Removal of the X virus from this complex left a dual virus which is responsible for virulent tuber blotch, and also produces streak symptoms in the foliage. This has been found to be identical with a potato 'streak' the symptoms of which were described earlier by Koch and Johnson, and thus is now shown to be caused by a mixture of top-necrosis and F viruses.

A Genus of the Discomycetes

A MONOGRAPH of the Discomycete genus Rutstrœmia has recently been published by W. Lawrence White (*Lloydia*, 4, No. 3, 153, September, 1941). There is no modern handbook to the genera and species of the Discomycetes, and any critical study like the present monograph is a welcome contribution. The genus Rutstrœmia was originally established by Karsten, and has been revived to include many of the inoperculate Discomycetes at present scattered through the current genera Helotium, Phialea, Ciboria, Sclerotinia and Cyathicula. Forty-one species are described critically, and the material has been obtained from as many countries as present world conditions allow. A key to the American species is given, and seventy-five half-tone figures elucidate the text.

Physiological Genetics of Neurospora

G. W. Beadle and E. L. Tatum (*Proc. Nat. Acad. Sci.*, 27, 499–506; 1941) describe useful methods for the analysis of gene action in biochemical phenomena. They irradiate the fungus Neurospora with X-rays and grow the resulting strains from single-spore culture on a medium containing as many of the synthesized products as possible. They also grow these spore strains on media containing only the primary ingredients. A normal strain is able to synthesize vitamin B_6, etc., from this latter medium, but a mutant strain may not survive through its inability to do so. By adding vitamin B_6 to such a medium, they can restore the growth-rate of the mutant strain to that of the normal strains. Out of two thousand single-spore cultures analysed, one was found to be pyridoxinless (unable to synthesize vitamin B_6), another failed to synthesize *p*-amino-benzoic acid, a further one could not synthesize thiazole. All these mutants differ from normal by one gene differences. The physiological methods of analysis which are used will enable the steps in synthesis to be studied in relation to gene changes.

Evolution of Continents

IN the Bruce-Preller lecture for 1941 Sir Thomas Holland discusses the data bearing on the highly controversial subject of continental drift, and makes suggestions towards a possible reconciliation of the conflicting evidence (*Proc. Roy. Soc. Edin.*, B, 61, II (13), 149; 1941). He directs attention to various geological lines of evidence "which cannot, so far as anyone knows, be explained in any way except by continental drift". The most formidable among these is the record of Upper Palæozoic glaciation on each of the now scattered continents of Gondwanaland. On the other hand, there is the geophysical difficulty of finding an adequate motive force for continental drift, if the view that the earth is solid and strong down to about half its radius be accepted as a scientific fact. Holland points to one obvious direction in which we may look hopefully for a clue to the reason for this apparent inconsistency: "the evidences for continental drift all belong to a relatively distant past", whereas "the seismic records . . . indicate the state of the Earth's interior to-day". He suggests that so long as geophysicists give good reasons for denying the physical possibility of continental drift, there are only two courses open: (i) to reconsider the possibility that some of the geological revolutions in the past were on a scale large enough to put the evidence of present-day conditions out of court; and (ii) to continue with the "prosaic task of accumulating more cold facts". The second of these is the more essential because by no means all geophysicists deny the physical possibility of continental drift. In this connexion reference may be made to the following papers: D. Griggs, *Amer. J. Sci.*, 237, 611; 1939; and B. Gutenberg, *Trans. Amer. Geophys. Union*, 556–58 (1941).

Activation of Nitrogen in the Silent Electric Discharge

S. S. Joshi and A. Purushotham, of Benares Hindu University, describe, in a communication to NATURE, dated November 17, 1941, some work on the formation of active nitrogen in a Siemens' ozonizer. Both alternating and unidirectional potentials were used. The walls of the ozonizer were suitably coated, and an idle volume was connected in series with the exhaust end of the ozonizer and the pump to act as a gas reservoir. With careful adjustment of the applied field and gas flow to suit the gas pressure, activation of nitrogen in the *silent discharge* was observed up to a pressure of 150 mm. mercury, using soft and pyrex glass tubes. By raising the frequency of the A.C. supply, both the yield and the maximum pressure could be increased appreciably; to do this it was necessary to use ozonizer tubes made of materials, such as silica, of high dielectric strength in order to withstand more intense fields; the walls were silvered. Apart, perhaps, from 'controlled electron' sources (Caress and Rideal, *Proc. Roy. Soc.*, A, 115, 684; 1927), with which the yield of active nitrogen was limited by the low pressure, the *silent discharge* was found to be the simplest in technique and most suitable for determining the electrical quantities characteristic of the reaction under given conditions. With the frequency n, the gas pressure p, and the temperature T kept constant, it was found (Joshi, *Current Science*, 8, 548; 1939) that as the applied potential was progressively increased, activation of the gas to produce a just perceptible afterglow set in at a critical potential V_m characterized by a sudden increase in both the electric current and the energy dissipated in the system. With constant n and T the critical potential increased sensibly linearly with p, the increase being pronounced at lower frequencies; at constant p and T the critical potential diminished with increasing n in the range 50–500 cycles per sec. Changes in V_m produced by admixture of a foreign gas or 'impurity' serve markedly to reveal its influence as a catalyst or otherwise in the activation of nitrogen. V_m resembles the corresponding Paschen potential. It is considered that ionization of nitrogen in one or more stages is a chief determinant of changes that precede its activation.

Laboratory Test for Preservation of Iron by Paint

To determine how well a paint protects a metal surface against corrosion, plaques covered with it are usually exposed outdoors. A laboratory test has recently been developed which shortens the weathering time to hours and does not destroy the film. The test, the technique of which is described by R. B. Gibney (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941), gives evidence as to how well a paint protects metal, but little information on the weathering of the paint itself. In the presence of water, metallic corrosion results from the electrochemical action between small adjacent surface areas, potential differences being set up between them. The potential of the whole surface is that of all the small areas involved, and can be measured with reference to a standard electrode. The extent of corrosion can be determined by recording continuously the potential changes of the metal over a few hours. Surface areas of a corroding metal are of two kinds: anodic (or electronegative), where the metal goes into solution, and cathodic (or electropositive) where hydrogen is evolved. If the metal corrodes freely the cathodic areas tend to become 'clogged' with hydrogen and the resultant potential of the plate becomes more electronegative. This effect is strongly accentuated when oxygen is excluded. If the metal does not corrode it is because the anodic areas become insulated with an extremely thin film of corrosion products, the potential of the plate being nearly that of the cathodic areas. Thus the potential of a corroding metal becomes more electronegative with time, while that of a non-corroding metal becomes and remains electropositive, and this is the basis for the rapid determination of the behaviour of painted iron.

Components of Fehling's Solution

IN a paper read before the Society of Public Analysts and Other Analytical Chemists on February 4, J. G. N. Gaskin described the curves obtained when the optical rotatory power (polarization) of mixtures of copper sulphate, alkali tartrate and caustic soda are plotted against increasing alkali contents of the solutions. Interpretation of these curves suggests the existence of copper complexes stabilized by alkali tartrate, and the isolation of one of these, having some unusual properties, is described. Some analytical data were given for compounds formed when copper sulphate is dissolved with excess of either Rochelle salt or potassium tartrate. The bearing of this work upon the constitution and possible modification of Fehling's solution is discussed.

Lithium Alum

THE existence of a lithium alum, $LiAl(SO_4)_2, 12H_2O$, has been the subject of some discussion, and the preparation of the compound is evidently a matter of some difficulty. J. F. Spencer and Oddie (NATURE, 138, 169; 1936) prepared it by working at low temperature, but H. A. Horan and Skarulis (*J. Amer. Chem. Soc.*, 61, 2689; 1939) failed to obtain it at 0°. H. A. Horan and J. J. Duane (*J. Amer. Chem. Soc.*, 63, 3533; 1941), however, now report that in equilibrium with saturated solutions an invariant point with solution composition differing from that previously reported by Horan and Skarulis has been found, and more careful investigation of the region between these invariant points clearly shows the existence of a third phase. The results indicate the formation of a double salt of composition $LiAl(SO_4)_2, 12H_2O$. Apparently the use of concentrated solutions of purified aluminium sulphate was the only difference in technique. The existence of lithium alum, with a limited region of existence, thus seems to be established, but some care is evidently necessary in its preparation.

GREEN LEAVES AS A SOURCE OF PROTEINS AND OTHER NUTRIENTS

IT is natural that the restriction of imports, and the changes in our dietetic habits that this has necessitated, should quicken our interest in the efficient production of food in Great Britain. In a few quarters, notably the immediate vicinity of the Ministry of Food, it is maintained that there is not now, and is not likely to be in the later stages of the War, a food shortage. Fortunately for the country most scientific workers concerned with nutrition or agriculture do not share this complacent attitude. Their interest was clearly shown at the discussion organized on February 11 by the Nutrition Panel of the Food Group of the Society of Chemical Industry. The papers read dealt mainly with carotene and other lipoids; there was discussion on this subject and on a project that had been circulated beforehand dealing with the large-scale isolation of protein from leaves for the feeding of people and other non-ruminants.

The vitamin content of leaves was compared with that of various other plant products by V. H. Booth. When taken at the right time of year leaves constitute a valuable source of ascorbic acid and of carotene, but ascorbic oxidase is so widespread that it is unlikely that products derived from leaves would be of much value in practice as sources of ascorbic acid. Samples of lard containing enough carotene to give 640 I.U. per ounce (the amount officially added to margarine) were shown and also samples in which only partially fractionated grass fat had been added to give the same carotene content. The former were about as dark as normal margarine and the latter, though darker, were not unpleasantly so. It was clear, from this survey, that leaves are not of great significance as a source of any of the other vitamins except K.

During storage, the carotene content of ground-dried lucerne leaves falls. R. O. Davies described this phenomenon in some detail and pointed out that the loss was only significant if the leaf meal was not cooled after coming from the drying plant and before storage. The fall is not continuous but a steady state is reached after 1–2 weeks; A. C. Pollard, on the other hand, found a continuous fall in the carotene content of ground-dried carrot pulp. No wholly satisfactory explanation of this difference was given, but it was suggested that there may be more than one isomer of carotene present; that carotene may only be readily oxidized in those cells that have been thoroughly damaged by the grinding; that there may be a difference in the oxidizability of carotene in the free and protein-bound states. The other lipoids of the leaf were described by H. S. Jefferies. 4 per cent of dried lucerne leaves is soluble in benzene and half of this dissolves in acetone. Phosphatides constitute 35–37 per cent of the total lipoids—an unusually high phosphatide/fat ratio. Less than 3 per cent of the lipoid is sterol and there appears to be no ergosterol in lucerne although the lipoids from grasses have been shown to contain about 1 per cent.

In the contribution taken as read at the meeting[1] it had been urged that research should be undertaken on the separation and purification of leaf protein and on the cultivation of crops that would give a good yield of protein per acre coupled with a leaf that, in terms of its dry weight, was rich in protein. The most immediately available material for this research would be the normal pasture mixture, but special grass mixtures or crops such as lucerne or maize may well turn out to be the most suitable in practice. The fresh leaves would be macerated and a protein-rich liquor separated from the leaf residue; the protein can readily be separated from the liquor by a number of treatments such as heat coagulation. Experience gained in the course of work on the pigments, enzymes and viruses in leaves suggests that about one third of the protein can easily be liberated in this way; a rather larger proportion comes out if the original crude protein content of the leaf is high, that is, more than 18 per cent. The leaf residue would therefore still contain about two thirds of the protein as well as all the fibre. From 140,000 acres it should be possible to prepare sufficient leaf protein to supply 1 gm. per head of population every day for a year. The aim of the research would therefore be to 'skim' off part of the protein of the leaf in a form suitable for the non-ruminant while leaving a residue suitable for use as a feeding-stuff for ruminants. If the research were successful, several advantages are claimed for this method of husbandry. The yield of protein of high biological value would be higher than that attainable from an acre by any other means; the fibre residue would be of relatively constant composition and of considerably greater feeding value than the hay that would probably have been made on the land had it not been used for this purpose; there is good reason to think that leaf protein would cost less than the other proteins that can be produced in Great Britain.

A. C. Chibnall agreed with the general principle of leaf protein extraction, but thought that it would be premature to start any research on these lines until our agricultural policy had undergone thorough reorganization. Difficulties were predicted both in the operation of an acreage sufficient to make a significant contribution to our protein supply and in the maintenance of a high leaf protein content. These difficulties did not impress R. O. Davies who has experience of farming more than ten thousand acres of lucerne; for five months out of the year the crop contained 17–28 per cent of crude protein.

Figures for the amino acid composition of protein isolated from cocksfoot grass were given by A. C. Chibnall, and he pointed out that this fraction of the total leaf protein contains all the amino acids that are known to be essential in the nutrition of the rat, in about the right amounts. Estimations of some of the amino acids in proteins from the leaves of several plants suggest that these proteins form a group of fairly uniform composition and of high 'biological value'. The need for feeding experiments to supplement these analyses was stressed by S. K. Kon, for leaf protein fed in the form of dried grass had a lower 'biological value' than Chibnall's figures would lead one to expect. These experiments, as A. L. Bacharach pointed out, should not be confined to the rat, but should be extended to some of the animals in the nutrition of which we are more immediately interested.

N. W. PIRIE.

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[1] N. W. Pirie, "The Direct Use of Leaf Protein in Human Nutrition", *Chem. and Ind.*, 61, 45 (1942).

PINE SHOOT BEETLES

An interesting account of pine shoot beetles has recently been published by Dr. Leon Ossowski (*Scot. Forest. J.*, 55. Part 2; 1941; Douglas and Foulis, Edinburgh). The author states that any forestry publication, British, Polish, German or Russian, is likely to contain an article on bark beetles and more especially the pine shoot beetles, which proves the destructive nature of these pests. In spite of many natural enemies the two pine shoot beetles are very plentiful, largely due, as Dr. Ossowski correctly states, to the usual technique of planting, "for planting concentrated in one year or on a single species gives a breeding ground for the beetles. Where we have natural regeneration and plantations of different ages and different species the beetles are rarely met with."

Equally correctly the author advocates that, in future, planting should not be confined to Scots pine, European larch and Norway spruce (33⅓ per cent of each) but that 30 per cent or even half of a plantation should consist of deciduous trees. It is an undoubted fact that in those temperate countries where considerable tracts of conifers either pure or mixed have been planted, sooner or later the areas have been visited by serious epidemics of pests—frequently the various bark beetles. There are others, for example, the plague of the pine noctuid (*Panolis piniperda* Panz) in Brandenburg and Pomerania in Germany, which laid waste thousands of hectares of coniferous woods during 1921–25; or the great devastation in the spruce forests in the Vosges (1903–05) by bark beetles. In spite of the well-known examples of widespread attack and heavy losses the lesson is difficult to learn apparently—for the pure conifer plantation is still being planted on a wide scale in temperate climates.

The author discusses some of the well-known methods of combating attacks and incidentally affords an interesting side-light on his own country, Poland.

"A striking example of the motto 'Back to Nature' is given by the woodlands of my own country. While in West Poland the woods are mainly coniferous, those of the North and North-east Poland are of a more mixed type with natural regeneration. Between 1920 and 1939 there were in West Poland two attacks of pine noctuid (1922–1925 and 1931–1933), two of the pine moth (*Dendrolimus pini*) and the pine looper (*Bupalus piniaria*) and one of the nun moth (*Liparis monacha*). The damage done by the insects was enormous and, so far as I can remember, through the noctuid plague of 1922–25 about 250,000 hectares of coniferous plantations must have been ruined, and in 1931–33 it cost 3,500,000 zloty (£140,000) to combat the evil. In the forests of North and North-east Poland, on the other hand, there were no great disasters from insect pests to record, and if here and there destructive insects appeared the trouble was only local and the loss not very great. As already stated, mixed plantations and a combination of tree groups of different ages give the best defence against bark beetles and destructive insects in general."

Research and experience are showing that much the same general rule applies to the broad-leaved species of fine timbers in the tropical and sub-tropical forests. It is becoming equally plain that the ordinary practising forester (or agriculturist, for that matter) finds it difficult to appreciate the fact until he faces a disaster.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, February 28

ROYAL SANITARY INSTITUTE (at the Nuffield Institute of Clinical Research, Oxford), at 10 a.m.—Mr. H. H. Crawley: "The Storage of Emergency Drinking Supplies"; Mr. Stewart Smith: "Administration of the Government Evacuation Scheme".

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Conference on "Food Production and Distribution in relation to Nutritional Needs". (Speakers: Sir John Orr, F.R.S., Dr. N. C. Wright, Mr. E. T. Halnan, and Sir John Russell, F.R.S.)

Monday, March 2

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Capt. G. S. Andrews: "Projects for the Alaska Highway Route".

Tuesday, March 3

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Metals", 1: "Metal Architecture".*

Wednesday, March 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Llewellyn S. Lloyd: "Modern Science and Musical Theory".

Thursday, March 5

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Dome Lounge, Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—Rt. Hon. Sir Montague Barlow, Bart.: "Decentralization and the Location of Industry".

Friday, March 6

PHYSICAL SOCIETY (OPTICAL GROUP) (at the Science Museum, Exhibition Road, London, S.W.7), at 11.15 a.m.—First General (Business) Meeting; at 11.30 a.m.—Dr. W. M. Hampton: "Problems relating to Optical Glass"; at 3 p.m. (in the Small Physics Lecture Theatre of the Imperial College, Imperial Institute Road, London, S.W.7)—Mr. R. J. Bracey: "A Multi-Purpose Collimator"; Mr. J. W. Perry: "Thermal Effects on the Performance of Lens Systems".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting; at 4.45 p.m.—Prof. J. W. Munro: "Entomology of Commerce".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, London, S.W.1), at 5.30 p.m.—Mr. B. J. Tams: "The Operation of the Mechanical Engineering Section of the Central Register in War Time".

Saturday, March 7

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. P. D. Stebbing: "A Review of References to Geology and Allied Subjects from the 16th Century" (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE LECTURER IN ENGINEERING—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (March 7).

LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Secretary, *Northampton Polytechnic, St. John Street, London*, E.C.1 (March 16).

SCIENTIFIC ASSISTANT (woman not liable for National Service)—The Deputy Director, Imperial Bureau of Pastures and Forage Crops, Agricultural Research Building, Penglais, Aberystwyth (March 21).

PROFESSOR OF EDUCATION—The Registrar, University College of Swansea, Singleton Park, Swansea (April 11).

ASSISTANT MECHANICAL ENGINEER for the Electrical Branch of the Nigerian Government Public Works Department—The Secretary, Central Register, Ministry of Labour and National Service, Queen Anne's Chambers, London, S.W.1 (quoting reference O.N.C.793).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 61, Part 2, No. 14: Quantitative Characters of the Growth and Development of a Paurometabolous Insect, *Dixippus (Carausius) morosus* Br. et Redt. 1: The Loss of Water in relation to Ecdysis. By Dr. Beverley N. Smallman. Pp. 167–185. 1*s.* 6*d.* Vol. 61, Part 2, No. 15: A Simple Apparatus for the Direct Determination of the Volume of Small Irregular Objects. By Dr. Beverley N. Smallman. Pp. 186–187. 6*d.* Vol. 61, Part 2, No. 16: Observations on Artificially Induced Heat in Immature Guinea Pigs. By Dr. P. Bacsich and Dr. G. M. Wyburn. Pp. 188–196+2 plates. 9*d.* (Edinburgh and London: Oliver and Boyd.) [52

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RELATION OF SCIENCE TO POLITICS

THE value of the Conference on Science and World Order in London last September lies largely in its emphasis on the increasingly close relation between science and government. For all its demonstration of the contribution which science could offer to the solution of the many problems of human welfare involved in the realization of the four freedoms, the Conference is more significant for the evidence it affords that the fundamental problem is that of securing the right relations between science and government. The full resources of science must be brought to bear on the problems of human welfare without impairing the freedom of thought, investigation and teaching upon which the very existence of science depends. While the independence of science is thus safeguarded, means must be found for securing the effective application of the knowledge acquired by disinterested and impartial research to the solution of social and economic problems and the service of human needs. The problem of the relation of knowledge and action is once again demanding an answer in terms of the needs of to-day and not the traditions of yesterday.

The discussions which have taken place since the Conference, and centring to some extent around the presidential address of Sir Henry Dale at the recent anniversary meeting of the Royal Society, on the relation of science to politics, like the conferences on science and the war effort convened by the Association of Scientific Workers, attest that the Declaration of Scientific Principles has been taken to heart by scientific workers. Conscious of the dangers to science and society inherent in the relations between science and politics, they are seeking to determine the conditions of advance. That much at least lies behind the various proposals regarding the organization of research in the social sciences and the establishment of a central institution for that purpose.

The address on Science and International Politics which was delivered by Sir Richard Gregory at the Royal Institute of International Affairs on February 2 (see p. 261 of this issue) should go far to clarify thought on this subject, which certainly must not be shunned because it bristles with difficulties and dangers. Admittedly there are departments of civil life which could with advantage make fuller and more systematic use of the scientific methods of inquiry into the factors which determine human conditions and potentialities to-day. To turn our back deliberately on such possibilities and to make no attempt to use that scientific knowledge which is our greatest power for social and political action is to deprive the Atlantic Charter of meaning, if not indeed to endanger the winning of the War itself.

Once we admit, as Sir Richard points out, that there are political leaders who can scarcely be said to take account of the changing conditions of life due to the applications of new scientific knowledge, either in the present or for the future, scientific workers can not rest content as citizens. They must make some effort to influence those in charge of the forces of science and who carry the responsibility of seeing that these are used effectively for the progressive welfare of the community. They must at least attempt to secure that the strength and disposition of the forces of science are given full consideration in all social and political campaigns. The fact that, as Sir Richard points out, few men of science feel able to transfer their trained habits of thought, does not absolve the body of scientific workers, either corporately or individually, from the responsibility of attempting to transfer to the consideration of social and political problems their training to face facts before arriving at judgments.

This, of course, is exactly what General Smuts urged in his Sidgwick Lecture on Democracy. It is only by applying to political problems the principles of independent inquiry and impartial judgment demanded of investigators in all branches of natural knowledge that politics can become a science and scientific workers as such can contribute to its advancement. Without this spirit and purpose, science and politics are best placed in different categories.

What has marked numerous discussions on social and economic questions of recent years is, however, the extent to which by making action possible on the basis of ascertained facts, science has taken problems out of the purview of party politics. Nutrition is an outstanding example of this kind. Political action is still required, but the question is no longer a party issue, and the power to be applied is that required to overcome vested or private interests as opposed to those of the community.

The natural extension of the boundaries of knowledge by the application of scientific method may thus, it is true, gradually extend the field within which action free from political prejudice is possible. We can not, however, rely on that process alone if effective action is to be taken to deal with many of our more urgent social problems before they bring worse in their train, any more than we should imagine that the scientific method alone will provide a solution. The effective implementation of this process involves three desiderata, with each of which the scientific worker is concerned: leaders and administrators competent to assess the results of scientific work and ready to apply them to the solution of the problems of to-day; a body of active younger scientific workers not merely extending the boundaries of knowledge but also able to formulate the questions to be asked, the problems to be attacked; and a body of public opinion sufficiently informed and powerful to overcome the opposition of any sectional interest to policies or action initiated in the general interest.

Prof. A. V. Hill's address last year to the annual general meeting of the Parliamentary and Scientific Committee contained specific proposals for forwarding the second of these needs, and the Scientific Advisory Committee, of which Lord Hankey is chairman, may yet do much to implement the first. It is the third condition, with the implied task of educating public opinion, that is possibly the most fundamental of all and which has yet to receive the attention it deserves from public opinion. Sir Richard Gregory's address is a contribution in this field which once again should earn him the gratitude of scientific workers.

There is, however, a further point to which Sir Richard directs attention. Repeatedly observers have noted the difference between the success of the League of Nations in its non-political work such as that of the International Health Organisation or the Opium Commission where technical considerations were the dominant factor, and its failure in those dominated by politics. Sir Richard suggests that international politics in which the world is a unit, of which all men are citizens with rights and duties to be adjusted wisely with the object of ensuring progressive development everywhere, is the field into which the international spirit of science can enter without being regarded as an intruder or becoming involved in controversial national politics. National boundaries have little relation to the distribution of national resources and less to the needs of modern life. All communities can share in the achievements of scientific discovery and invention, and the tendency towards larger political units gives promise of further expansion into a commonwealth of the chief free peoples of the world.

Such a commonwealth can only be secured by consent, and as Sir Richard reminds us, no new world order can be stable unless each nation is free to follow its own lines of cultural development, and does not seek to deprive others of the same liberty. With such a co-operative alliance in mind—already embryonic in the fourth point of the Atlantic Charter—the services of science can be used to shape the course of international politics. As already noted, advancing knowledge is taking welfare policy out of the field of party politics both in the national and in the international spheres. Knowledge of natural objects and phenomena is the foundation upon which modern civilization is based. It is continually revealing new sources of supply of materials and power to expand this structure. Applied science has provided the means of making the world's abundance available to all men, and the aim of international politics should be to see that the supply is adjusted according to the need for its use.

Such an outlook on world order is as implicit in the Atlantic Charter as in the four freedoms of President Roosevelt, and it should already be clear that its realization depends very really on the co-operation of men of science. While, however, what exists in the world, and what uses can be made of it, are discovered by scientific inquiry, what action is taken on this basis depends upon communities and their governments. For this reason the view that the sole function of men of science is to study and discover natural facts and principles without regard to their social implications is no longer tenable. Not only have they special responsibility for recording their opinion in matters in which their pursuits affect the welfare of the community, but also the obligation as citizens to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown because the powers they have released have not been rightly used in the service of mankind as a whole.

It is at this point that Sir Richard's address is linked up with an article "Science to Re-build" in the November issue of *Current Science* (India). Admittedly the Atlantic Charter gives new hope for the establishment of a world order in which the fundamental rights of men and communities will be defined and acknowledged and in which science will be able to serve more effectively the needs of mankind. Such rights and principles must, however, be formulated more clearly than has yet been done if reconstruction is to prove effective, and science can well combine with politics, as Sir Richard suggests, in the determination of such principles and in arriving at a sound basis for the constitution and judgments of a court of international politics.

The article in *Current Science* indicates further steps to be taken, notably in the extension of scientific knowledge in those fields where it would assist man to acquire control over his own nature corresponding with his control over material resources. Besides, it is essential that even such declarations as the Atlantic Charter should be submitted to careful and scientific scrutiny. Already there have been some differences of interpretation of, or at least of emphasis on, the various clauses and if misunderstandings are to be avoided certain of these points must be elucidated in the near future.

In the modern world to-day not even an Anglo-American declaration of policy can avoid facing the colour question, and the article in *Current Science* is on firm ground in directing attention to the omission of any reference to such countries as India, and again in insisting that the first axiom in world planning is that the prime motive force of life is hunger, which knows no distinction of colour. No world order which does not take into account the needs of coloured as well as of the white races can be regarded as either scientific or durable.

On other specific points of the Atlantic Charter this article is equally searching. In regard to territorial settlements it points out that an expert body of economists, demographers and other specialists will be required to furnish the necessary advice on particular settlements if such settlements are to be free from any sense of unfairness. It challenges the durability of any settlement respecting the right of all peoples to choose the form of government under which they will live, unless in practice that government is some form of democracy. It raises the question of the responsibility of scientific men in respect of disarmament with reference to work likely to be useful for military purposes, and suggests that such researches should be submitted for examination and their report on results for control by an international agency.

In the field of economic development some of the implications of the Charter are indicated, such as open markets, the supply of technical knowledge and skill and industrial machinery, and an international bank or finance corporation to lend money for development purposes, free from political, military or trading obligations.

It is abundantly clear that there is an immense field in which fundamental thinking is required before we can implement many of the principles of the Atlantic Charter or assess rightly the schemes of reconstruction which must be worked out in readiness even in the dark and exacting days of war. To that thinking science has much to contribute. Corporately and individually scientific workers can also do much to forward the task of reconstruction in fields where they bear special responsibility, as has already been recognized by engineers, physicists, medical men and architects in the formation of special planning committees or commissions. There are, however, many sections of scientific workers who have shown little sign of recognition of their responsibility in this field and it may well be hoped that Sir Richard Gregory's address will not only stimulate such to action, but also scientific workers generally, to consider more carefully the appropriateness and effectiveness of the machinery which already exists for integrating the relations of science and politics, whether at the top in the Scientific Advisory Committee, in the arrangements for widening the outlook and experience of the active young minds engaged in scientific work, to which Prof. A. V. Hill has specially referred, or in that fundamental task of educating the public mind so that it can reach sound decisions and supply the power to overcome private interests which hold up action demanded by the public interest. As these lines are explored with the world vision and perspective which Sir Richard emphasizes, the relations between science and politics will become more clearly delineated, while the claims of science to be free from any form of pressure in pursuing her work are established beyond challenge.

SKILLED MAN-POWER IN THE SERVICES

THE importance of wise utilization of skilled man-power if we are to develop the maximum production and war effort has been emphasized by recent events, and its realization has been implicit throughout recent debates and discussions in Parliament and elsewhere. If the second report of the Beveridge Committee on Skilled Men in the Services* will not altogether dispel misgivings on that ground, there are certain points on which it gives welcome reassurance.

The Committee is able to answer unhesitatingly that the Navy is using the skilled man-power at its disposal with due economy and effect, except in regard to naval reservists, where the measures already taken for transfer of qualified men to skilled work need to be repeated and reinforced until they achieve success. Better use is being made of skilled engineers in the Navy than in either the Army or Air Force. Although the problems in the Navy are simpler, they would not be solved as completely as they are, unless the Navy possessed, as it does, good arrangements in respect of trade testing, search for talent, technical training, review of establishments, interim use of engineers and self-scrutiny. The trade testing of the Navy is centralized, standardized, and objective. Any skilled engineer volunteering for the Navy knows that he will have a fair test, and that if he passes, he will be ranked forthwith as a petty officer and employed as an engineer. There is organized search for talent in the Navy and, while in the development of new training establishments the Navy has less to show than either of the other Services, the regular establishments are excellent and their procedure has been adjusted to war conditions. By better use of some of the naval reservists, the Committee estimates that it should be possible to meet some 10 per cent of the demands of the Navy for skilled men during the period ending March 31, 1942, but substantial additional numbers will be required.

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* Committee on Skilled Men in the Services: Second Report and a Memorandum by the War Office. Pp. 74. (London: H. M. Stationery Office, 1942.) 1*s*. 3*d*. net.

The Air Force stands intermediate between the older Services, in size, in rate of expansion, and in the complexity of its problems. It is also not so clear of complaints of unused skill as is the Navy; but, while it has nothing comparable in scale to the misfits and misapplications that appear in some parts of the Army, it shows sufficient misfits to call for expansion of the measures which have already been taken to deal with such cases. The Committee considers that the machinery for sorting, selecting and trade testing should be re-examined, and such barriers as remain should be reconsidered.

The situation with regard to the Army is less satisfactory, and substantial changes of organization and machinery are likely to be required before it can be said that the skilled man-power already at the disposal of this Service is being used with due economy and effect. There are, of course, several factors which have made the adjustment of supply to demand and full use of skilled men harder for the Army than it is for either of the other Services, or for civilian industry. The Army has expanded more than either of the other Services and much more than the munitions industries, and its rate of growth has been subject to violent fluctuations. An industrial organization which after a comparable period of growth was subjected to a similarly thorough scrutiny would be lucky it it failed to show many misfits.

At the beginning of the War, the Army received numbers of men, either called up as territorials and reservists or posted as militia, in regard to whom it was not possible to exercise selection in assigning them to appropriate trades or units. In addition, the Army, while growing, has had to change its character by progressive increase in the proportions of armoured and mechanized divisions. The character of the War, with the serious loss of equipment in France and the subsequent prolonged restoration and waiting in England, have added to the difficulties of adequate use of the man-power in the Army, but one of the most fundamental difficulties is the structure of the Army as a combination of distinct corps and of units, often with strong local associations or sectional traditions, and consequent obstacles to transfer.

All the investigations of the Committee point to the conclusion that the reservoir of unused engineering skill already in the Army is greater than the revised requirements for skilled men of engineering and allied occupations laid before it by the War Office. While this does not mean that all such requirements can be met from within the Army, it does involve certain major changes, notably the technical review of establishments, the pooling of mechanical reserves, and the reorganization of selecting, sorting and trade-testing arrangements. The older Army training establishments are regarded as excellent. Its new training establishments are an improvisation deserving of great praise; good in themselves, they need to be fitted more closely into the organization of the Army as a whole, with better selection of trainees and with closer adjustment to the practical problems which the trainees will have to solve.

The report advances two major proposals for consideration, rather than as recommendations: enlistment into the Army not for corps, but as a single Service; and the establishment of a Corps of Mechanical Engineers. Fundamental to this and to the vital changes recommended, and a condition of their achievement, is that mechanical and electrical engineering, as distinct from civil engineering, should be given their proper place and authority in the higher councils of the Army. Review of establishments on the lines suggested may achieve substantial economies of skilled men in the Army without undue risk, but the vital need is for a new outlook, for new methods for new tasks. Mechanization of an army, as the Committee observes, should begin from the top.

When full allowance has been made for all disturbing factors, and in spite of the vigorous efforts made in all three Services to bring about a re-mustering and using of men according to their skill, the extent to which men of rare skill find that skill unused in the Forces, in the Committee's judgment, remains disturbing and surprising. It is fully recognized that many forms of skill which are valuable in peace cannot be turned to account in war, and that the essential problem of skilled men in the Services is that of how to be ready for emergencies without wasting more than the irreducible minimum of skill in standing-by. The organization of war is largely a question of priorities, and in regard to engineers the Committee has been guided by two principles: the first priority in war is for whatever may be needed to keep the machines of war in action; and second, in war engineers are for those who can and will use them as engineers.

The Committee points out that, on the first principle, skilled engineers and spare parts are alternative means of securing the maintenance of machines of war, and its lucid argument shows a clearer grasp than the War Office in its accompanying memorandum of what General Wavell termed the "mechanism of war" and the real foundation of military knowledge in his lectures on "Generals and Generalship". While, therefore, the full investigations leave unchanged the main conclusion of the interim report that an increase in the skilled personnel of the

Services is inevitable, and that more engineers must be drawn from civilian industry for the Services, there is a clear possibility that the unused reservoir of engineering skill in the Army is large enough and varied enough to meet all the requirements submitted to the Committee for men of engineering skill.

The whole tone of the War Office memorandum published with the report betrays a disquieting failure to see the situation in its true perspective of either time or resources, and the subsequent speech by the Secretary of State for War in the House of Commons was even less reassuring. Some of the points raised in the War Office memorandum deserve careful consideration, but a frame of mind and a condition of organization which have already taken three and a half months to produce this memorandum on the report with the remark that so important a recommendation as the creation of a Corps of Mechanical Engineers is still under consideration are profoundly disturbing. The War Office cannot avoid the issue by the naive suggestion that the Beveridge Committee brings to its task merely the standards of industrial practice. The problem of a trained, equipped and maintained army and its industrial background must be seen as a whole, and if the Army's present leaders cannot see the problem thus and weed out wasters as well as waste at every rank, they must be replaced by those who can.

It should not be thought, however, that in spite of the procrastination of the higher command in dealing with the two major proposals, the Army is making no attempt at a more scientific use of its resources of man-power, skilled or unskilled. Lieut.-General Sir Ronald Adam recently gave an encouraging account of the selection tests for avoiding misfits which have already been developed under the Advisory Committee, composed of Prof. J. Drever, Dr. C. S. Myers, Prof. F. C. Bartlett and Prof. C. Burt, appointed last June to assist the Director of Personnel Selection. Moreover, a thorough analysis is being made of every job in the Army and experiments are being made in leadership tests, based to some extent on German practice, for use in selecting men for training as officers, and directed to ensuring that a leader is more intelligent, has quicker reactions and more personality than the men he leads.

General Adams's statement that a large-scale experiment has been started by enlisting men into a general service corps and putting them through a basic training course before deciding for which corps they are best suited indicates a greater receptivity to new ideas than is apparent in the War Office memorandum.

A more promising attitude is also to be found in the War Office observations on the twenty-second Report of the Select Committee on National Expenditure, which have now appeared in the Select Committee's first report of the 1941–42 Series. The memorandum states that the directorate of Selection of Personnel has a staff of 15 officers and 150 N.C.O.s (including A.T.S.) and has been approved to carry out selection tests on the personnel both of intakes and of existing units. While upholding the value of the military interview, the memorandum recognizes that the selection test is complementary and that the value of the interview will be greatly increased if the interviewing officer has before him the result of the man's selection test. The War Office would welcome a system of compulsory intelligence testing of all intakes, regardless of their preference, to be carried out under the auspices of the Ministry of Labour.

Discussing the Select Committee's recommendation for the establishment of central depots for classification before posting, the same argument is advanced as that against the proposal of the Beveridge Committee, but it is admitted that the basic training centre system is already in use for the A.T.S. As regards the discharge of unsuitable personnel, the War Office urges that this must be weighed carefully against the man-power situation. The War Office agrees that intelligence is one of the principal factors in the make-up of a potential officer, and that no candidate should be sent to an officer cadet training unit whose intelligence as measured by a test does not reach a certain standard. The time to apply such a test is under investigation, and it is proposed that all candidates should be given an intelligence test before their interview by a Command Interviewing Board.

These observations will do something to reassure opinion as to the readiness of the Army to rectify past mistakes and improve its technique and organization in these vital matters. Sir Edward Grigg's speech following Capt. Margesson's in the debate on the Army Estimates, was, however, somewhat disturbing from the point of view of the outlook betrayed. The statement that only 9 per cent of officers in the Army had had a university education can reflect equally on the capacity of the universities to train men for leadership and on the ability of the Army to recognize potential leaders. But it cannot be discussed without some knowledge of the numbers of university men available for meeting Army requirements and of the extent and nature of the Army's requirements for officers.

The statement should not be allowed to pass unnoticed, because of the implication contained in the whole context that a high standard of education is unnecessary in meeting Army requirements. Fundamentally, it may well be found that the blows which we have recently suffered are due at least in part to defects of leadership from top to bottom of the Services, which can in turn be traced to the neglect and indifference of people and Government alike to the real issues of education. Sir Edward Grigg fundamentally misconstrued the attack on recruitment of officers from the public schools. The objection to that system is that it places recruitment on a class basis, and does not tap the larger reserves of leadership available in the nation. Moreover, until some system of intelligence test is imposed in accordance with the War Office memorandum, on all entrants to officers training establishments, from Sandhurst and Woolwich downwards, there will be no satisfactory obstacle to such factors as social or economic position admitting men ultimately to positions of responsibility which they lack the character or ability to discharge.

The appearance of the Beveridge Report and the accompanying memorandum, however, should not be without a steadying influence on the public mind. They represent a great challenge to constructive thought which scientific workers should be quick to accept. Their implications strike far into the causes of our present difficulties, and there are few indeed who cannot see in this analysis some bearing on their own task and part in the war effort, and an indication of how that contribution can be increased. The solid reasons for confidence contained in the Report, and the picture of admirable work already being done, only emphasize the urgency for doing quickly what more remains to be done. On every citizen lies the responsibility for seeing that there is no waste of skill, men or material, and when he has done his or her utmost in his own special sphere, there lies that corporate responsibility of compelling effective and urgent action, through Parliament and the sheer force of public opinion, wherever indifference, neglect, incompetence or lack of interest perpetuates inefficiency and waste.

FIREFLIES

Living Light

By E. Newton Harvey. Pp. xv+328. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1940.) 24*s.* net.

A GLOW-WORM in the grass and fire dripping from the oar are two things which once seen are never to be forgotten. Faraday, posting through Italy with Sir Humphry Davy, found "entertainment and delight" in the fireflies by the way. When the *Challenger* entered the Guinea Current, soon after her voyage began, the sea was "a perfect blaze of phosphorescence"; and long afterwards Wyville Thomson used to tell us how the Pyrosomas glowed in the water like bars of white-hot steel. Sir Joseph Banks had found his *Medusa pellucens* (akin to our *Pelagia noctiluca*) in the same waters, and thought it the most splendid of the luminous inhabitants of the ocean; its flashes of light, he said, were so vivid as to affect the sight of the observer. And Humboldt speaks with his great voice of that "magic brightness", which is part of the joy of those who, like himself, have a peculiar predilection for the sea.

The shellfish (Pholas) which, according to Pliny, seem on fire as they go down your throat—*velut igne lucentes in tenebris, etiam in ore mandentium*; the splendid brief intensity of the Bermuda fireworm; the little lanterns of the deep-sea fish which the dredge brings up and which Dr. Beebe goes down to see; the little squid at Messina which surround themselves with liquid fire instead of a screen of ink—all these are part of the multitudinous phenomenon which Prof. Newton Harvey lovingly and enthusiastically describes. Every now and then our wonderment grows greater still over some new feature of the display, such as the flashing of certain fireflies in periodic synchronism. "At one time [in Siam] every leaf and branch appears decorated with diamond-like fire; but soon there is darkness, to be again succeeded by flashes from innumerable lamps."

For thirty years at least Prof. Newton Harvey and the students in his Princeton laboratory have been studying the phenomena of luminescence. They have turned out among them a host of well-known papers, and his friend, Prof. Ulric Dahlgren, has been as busy on the histological side as Prof. Harvey on the experimental and biochemical; indeed, Prof. Harvey seems just a little weighed down in the writing of this book by the superabundance of his own knowledge. He gives us a useful bibliography of some thirty pages; but this, he tells us, is a mere nothing, so vast is the literature of the subject. A hundred years ago, in his famous work, "Das Leuchten des Meeres", Ehrenberg cited between four and five hundred older books and papers, very few of which Prof. Harvey finds room, or thinks it necessary, to quote again.

But to sum up. After giving a third of his book to the description of all manner of phosphorescent organisms, Prof. Harvey goes on to deal with the physics, the chemistry and the physiology of the subject. He describes the various types of luminescence from the physicist's point of view. He goes on to the chemistry of luminescence, and is particularly interested in the curious substance described sixty years ago by Dubois as luciferine, along with its enzyme luciferase. An interesting chapter follows on the physiology of luminescence; and the last chapter of all (which interests me less) is on the physical nature of light. Of the many illustrations, some are curiously beautiful, especially the frontispiece, which shows some of Dr. Beebe's deep-sea fishes in pursuit of little scarlet and luminous squid.

The author is generous in crediting to its discoverer almost every fact which he records; but it cramps his literary style somewhat to quote fifteen or eighteen authors on a page, along with the dates of their several publications. The book has its share of misprints, but its blunders, so far as I can see, are few. The Nemertean worms are not so called from the 'unerring' aim of their proboscides, but merely as a literary allusion to Hesiod's description of the father of all the Nereids, the wise Old Man of the Sea. And as to Fulgora, whose time-honoured reputation as a 'lantern-fly' now comes in question, it would be all very well to call it a 'bug', but to call it a *beetle* won't do.

D'Arcy W. Thompson.

THE LIVING SPIDER

The Comity of Spiders

By Dr. William Syer Bristowe. Vol. 2. (Ray Society Volume for the Year 1940.) Pp. xiv+229–560+3 plates. (London: Bernard Quaritch, Ltd., 1941.) 25*s.* net.

ALTHOUGH Dr. Bristowe writes in his preface that the War has affected his work on spiders and even his enthusiasm it is difficult for the reader to detect many signs of this in the volume which concludes the work first published in 1939. The subjects with which he is now concerned are food and its capture, danger and its avoidance, courtship and mating. On these matters he gives us a summary of his own investigations—which began, he tells us, at the age of four—supplemented by some contributions from the work of other araneologists.

In the first chapter, which deals with the capture of the prey, Dr. Bristowe analyses the varied methods employed, classifies the types of web and gives his views on the difficult subject of the evolution of the web. The clue that he offers in solving this problem is the suggestion that silk was first used as a protective cover for the eggs; at the same time the tracing of the evolutionary path is complicated by the fact that the same type of web may more than once have arisen independently.

In discussing the nature of spiders' food, Dr. Bristowe corrects the vague impression that spiders generally will eat any small living animal. He does this by a very full account of experiments on the acceptance or refusal of many insects and other arthropods by many kinds of spider. The insects are passed in review, order by order, and precise information is given of the results of offering them to spiders of many genera. Usually the actual species of spider and of insect are recorded, and the result is a large body of exact and reliable information on a subject which has not previously attracted the attention it is now shown to deserve. One of the most interesting of the many points emphasized is the fact that often, after biting and rejecting a nauseous insect, the spider is seen to "wipe its mouth" on a convenient leaf or the neighbouring wall.

Dr. Bristowe next turns his attention to the opposite side of the picture: from those animals a spider will eat to the correlative question of the animals that will eat a spider. The same admirably precise information is recorded. The enemies, parasites and predators are taken order by order. The longest sections here are concerned with Ichneumons and other spiders among invertebrates, with fish and birds among vertebrates. The great popularity of ornithology enables quantitative estimates to be given here, and the section concludes with a striking table of the estimated spider-consumption of sixteen species of British birds. These range from starlings, credited with a total consumption of 10,000 million spiders annually, to rooks, which are responsible for a mere twenty-five million. The spider's protection against its enemies seems to be chiefly the well-tried methods of protective resemblance and mimicry.

In the chapter on mating habits Dr. Bristowe is writing on a subject that he has made peculiarly his own. He now gives us a survey of the whole process, from the remarkable sperm-induction to the male spider's chance of escaping from his mate with his life.

Dr. Bristowe dedicates this second volume to the naturalists of all nations, and this fact, together with the curious title of the book, may be taken as an expression of his intention to write as a naturalist rather than as a biologist or a zoologist. In so doing he has shown that it is possible to learn a great deal about the habits of animals and to understand, so far as that may be done, something of their mode of life, without the use of any theory of animal behaviour. He is concerned only to describe events, and he does so in a manner that, while he now avoids anthropomorphic and specifically teleological statements, gives a picturesque and even an exciting impression of what he has seen. But he refrains from debate as to whether reflex, tropistic or instinctive behaviour gives the best method of scientific description of any activity.

In his last chapter, however, he deals with a question of broader biological significance, namely, the dominance of Linyphiid spiders in temperate regions. He concludes that this is due to the favourable climate, the abundant food supply and a partial immunity from the attacks of some of the spider's enemies.

The book is illustrated chiefly by clear line diagrams with a few photographic plates, which, it must be confessed, demonstrate the marked superiority of line over photography where spiders are concerned. A word of praise should be given to the apt choice of unusual quotations which have provided the chapter mottoes. Nor should the industry which has compiled the very useful index of every specific name used in British spider literature be unmentioned.

Taken together, Dr. Bristowe's two volumes constitute a notable piece of work and one which should facilitate and encourage the study of British spiders when international affairs once more permit the prosecution of peace-time occupations.

T. H. SAVORY.

FOURIER SERIES AND SOME APPLICATIONS

Fourier Series and Boundary Value Problems

By Prof. Ruel V. Churchill. Pp. ix+206. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 17*s*. 6*d*.

IN the development of human knowledge, and particularly in science and mathematics, any great discovery stands out as a beacon to mark progress made in a certain direction. But it reveals also paths of possible further advance upon which other research workers may begin to tread. In time, these workers may light up new beacons until a whole region becomes illuminated with increasing intensity. The discrete points of light thus tend to lose their separate identities by merging themselves into a flaming torch—discontinuity seems, in fact, to become continuity. So, in particular, one great mathematical discovery opens the way for many others until previously accepted concepts become broadened into a much more powerful generalization which, as history reveals, so absorbs the contributory steps that they almost lose their individual entities. This fact is well illustrated by the subject of the volume under review.

While trigonometric series were first introduced in analysis by Daniel Bernoulli and Euler in connexion with problems on vibration, and by Legendre and Laplace in the theory of gravitational potential, it was the great work of J. B. J. Fourier (1768–1830), in showing that quite arbitrary discontinuous curves could be represented analytically by means of infinite trigonometric series, that opened the way to laying the subject upon a sure foundation. In the process, as Boyer remarks[1], "the attitude towards the function concept became broader". This was made manifest by the subsequent work of Cauchy in which a new notion of continuity was developed. One modern writer has declared[2] that the theory of Fourier series is "one of the most beautiful results of analysis and serves as an indispensable instrument in the treatment of nearly every physical problem".

Prof. Churchill's volume admirably illustrates this truth although the author only claims his book to be an introduction to the subject. It is concerned with the two related and general problems: the expansion of an arbitrary function into a Fourier series, and the boundary value problems in the partial differential equations of physics and engineering. Before dealing with the essential theory of the Fourier series, the first three chapters are devoted to an introduction to the subject, the partial differential equations of physics and a succinct account of orthogonal sets of functions. Chapters 4 and 5 treat of the Fourier series proper, their various forms, fundamental properties and Fourier integrals, all of which are well discussed. Applications to boundary value problems then follow as the main subject-matter of the remaining four chapters. In these, the essential theoretical aspect, such as uniform convergence, uniqueness theorems, etc., are considered in their relation to the solution of the important problems connected with vibration, temperature, electric potential, and so on. Finally, Bessel functions and Legendre polynomials, with their respective applications to radiation, vibration and gravitational potential due to a circular plate, bring a very interesting and instructive course to a conclusion.

The book is excellently printed and abounds in illustrative examples and problems in wide variety for the student. Answers to most of the latter are provided, and references for further reading are given at the ends of most of the chapters.

The author's aim to render the course "both elementary and mathematically sound" has been skilfully carried out and the book is a valuable contribution to the subject.

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[1] Boyer, "The Concepts of the Calculus", p. 277 (New York: Columbia Press, 1939).

[2] Sokolinkoff, "Higher Mathematics for Engineers and Physicists", p. 135.

POLYMERIC REACTIONS

High Polymeric Reactions

Their Theory and Practice. By Prof. H. Mark and R. Raff. Translated from the Manuscript by Luise Harris Weissberger and I. P. Irany. (High Polymers, Vol. 3.) Pp. xiii+476. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1941.) 39s. net.

THIS is the first book exclusively devoted to an examination of the mechanism of polymerization reactions. Such reactions can now be well enough controlled to make practicable quantitative measurements on the rate processes involved. Consequently it becomes possible to inquire how chemical kinetics can throw light on the nature of the elementary types of reaction in the polymerization mechanism. In this respect it is a virgin field, and in spite of considerable effort there is still much to be done before a clear and reliable picture of polymerization may be constructed.

Admittedly the problem is much simplified by the development of the detailed theory of chain reactions started some fifteen years ago, but the theory of polymerization reactions has to do a good deal more than the straightforward chain theory. Here in essence it was necessary to deal with only two active molecules or chain propagators, and establish their identity and reaction velocity coefficients. With polymer reactions, on the other hand, the nature and reactivity of *each* polymer must be determined not only as a matter of kinetic interest but also as a prerequisite in calculating concentrations of the several polymers formed after the reaction has ceased. In addition, there are further complications. Linear chain polymers are not necessarily built up by a chain type of mechanism in the sense that one molecule of catalyst may induce the polymerization of many molecules of monomer. For example, in polycondensations it is certain that the polymer is built up step by step by a series of essentially similar reactions. Again, it is found in some reactions that, once started, they seem to proceed indefinitely provided monomer is continuously supplied to the growing polymer. The result is that the convenient and powerful stationary state method of analysis cannot be applied. Complexity reaches its peak when, to any one of these processes, are added the phenomena of the branching and subsequent cross-linking of the linear chains to form three-dimensional networks. Explosive or indefinitely rapid polymerization has not so far been observed, and hence the theory of branching chains provides no help at present.

It is therefore no mean task to devise methods which will yield quantitative information about the molecular statistics of so diverse a series of processes. The volume under review gives a description of the efforts that have been made in recent years to tackle some of these problems. The first part gives an account of the structure of high polymers and their physical and chemical characteristics. There follows next a comprehensive description of the experimental methods employed to trace the course of polymer reactions—a section which will be of particular interest, as the methods are manifold and widely scattered in the literature.

A considerable portion of Part 1 is devoted to the consideration of general reaction kinetics. This subject has received so much publicity that the newer material is at last finding its way into text-books and thus its reproduction here is not so necessary. On the other hand, it makes the volume complete in itself. Thereafter follows the theory of polymer reactions. Its particular form follows closely the presentation which has been adopted by Prof. Mark and his collaborators in previously published work. Here there are many controversial points, but since the assumptions made are often extremely difficult to check experimentally, there is no point in discussing the more detailed parts of the theory provided it is realized that modification in the near future is almost inevitable.

Reference is made in Part 1 to some of the experimental work on the kinetics of polymerization, but the main account of the behaviour of various types of monomer is reserved for Part 2, in which each individual reaction is considered separately and all the relevant facts brought to notice. While this is invaluable as a compilation, it is disappointing to anyone primarily interested in discovering just how far kinetic analysis may be pushed in the examination of these reactions. Many of the reactions have, of course, not been studied in such a way that the data are suitable for analysis, and therefore strictly should be excluded. On the other hand, this lack of knowledge serves to emphasize where further work is needed and what reactions are most likely to be amenable to kinetic discipline.

This volume is, in short, a survey of the beginnings of a new subject and is in no sense a description of a rigorously developed theory supported adequately by exact measurements. It must therefore be read in this spirit. Prof. Mark and Dr. Raff may be congratulated on having the courage to attempt to bring coherence into a fresh region of reaction kinetics.

H. W. MELVILLE.

SCIENCE AND INTERNATIONAL POLITICS*

By SIR RICHARD GREGORY, Bart, F.R.S.

It was with a certain amount of reluctance that I accepted the invitation to address the Royal Institute of International Affairs upon the subject of "Science and International Politics". My hesitation was largely due to views expressed in the public press and elsewhere, after the recent Conference in London on Science and World Order, as to the desirability or otherwise of keeping science and politics within the particular fields of action commonly assigned to them. The Conference was organized by the Division for the Social and International Relations of Science of the British Association.

As science is an international study, the intention of the organizers of the Conference was to have the subjects of the programme presented from a world point of view. So far as I know, this was the first occasion on which many leading representatives of science, politics, and sociology, from many different countries, assembled with the common object of understanding each other's attitudes towards the subjects brought forward. It is not surprising that relationships of science to systems of government and to social problems attracted great public attention to the Conference, and that there were differences of opinion as to the value to the community of close or loose contacts between them. In countries where all the forces of science belong to a State service, the pursuit of knowledge for its own sake is not an organic part of the scheme of action, however much satisfaction it may give to individuals who undertake it, or however valuable the discoveries made may prove ultimately to be. Where science is regimented, no distinction is made between academic and applied scientists, and operations are assigned to each in the plan of campaign. Team-work is organized in the service of the State instead of being left to sporadic initiative.

This system of State planning of the pursuit of scientific knowledge with practical purpose as the aim is responsible for the great advances in science and industry achieved in the U.S.S.R. in recent years; and it has supporters among men of science in Great Britain. The basis of the system is obviously communistic; and British men of science who approve of it are regarded as both scientific and political revolutionaries whose activities are a danger to scientific freedom. Liberty of thought, work and expression is highly cherished in the commonwealth of science, and in Great Britain no conditions which would limit it would be tolerated. As citizens, men of science have the right to hold any political or religious faith, and the duty also of justifying it when needed. The general view is, however, that they should not embarrass science by advocating doctrines which would make her the handmaid of a particular political party.

This view was expressed by Sir Henry Dale in his presidential address delivered at the recent anniversary meeting of the Royal Society. "I see danger", he said, "if the name of science, or the very cause of its freedom, should become involved as a battle cry in a campaign on behalf of any political system, whether its opponents would describe it as revolutionary or reactionary. If science were allowed thus to be used as a weapon of political pressure, it would be impossible to protect science itself from the pressure of sectional politics".

Sir Henry Dale's remarks led to correspondence in *The Times* on science and politics and the organization of research in the social sciences. No one suggested that an authority in a particular branch of natural science could be assumed to have expert knowledge and experience in the fields of the political and social sciences. On the other hand, it was acknowledged that these departments of civil life could with advantage make fuller and more systematic use of scientific methods of inquiry into the factors which determine human conditions and potentialities to-day.

By modern use, science has come to signify natural philosophy, or verifiable knowledge acquired by observation and experiment. When its field of work is thus defined, there is an impermeable membrane between science and politics. The partition is dissolved when science—the domain of reason—is defined as systematic and formulated knowledge in all fields of human understanding—natural, moral, social and political. At all stages of civilization, these factors have determined the conditions of human life in varying degrees; and in modern times scientific knowledge has been the chief element in the constitution of man's outlook and the greatest power for social and political action.

As science, using the word in the sense now generally understood, is kept apart from politics, it has little influence upon the uses to which its power is applied, whether for good or evil. In general, this influence is not given effective attention in political and social philosophies; and the attitude towards it to-day is much the same as that of Plato towards the results of observational and practical inquiry represented by the Ionian school, upon the principles of which physical science may be said to be founded. In Platonic politics, the State decided what was good for the peoples to know and accept, and the purpose of legislation was to ensure the stability of a society of rulers and slaves. The spirit of political Platonism still prevails, even though modern science and technology have placed a score of mechanical slaves at the disposal of every citizen in a modern State.

In the understanding of this increased power, and in action based upon it, political leaders can scarcely be said to take adequate account of the changing conditions of life due to applications of new scientific knowledge, either in the present or for the future. They are in charge of the forces of science, and upon them is the responsibility of seeing that these are used effectively for the progressive welfare of the community. In this relation to politics, the functions of science may be compared with those of an intelligence department which possesses knowledge of the equipment available everywhere for social or political development, but has no influence upon action derivable from it.

In a democratic State, the uses made of science, like those provided for defence or attack on land, sea and air, are decided by leaders elected by representatives of the people. If these representatives rarely include men distinguished for their contributions to useful knowledge, it is because such original investigators find the air of the research laboratory more congenial and productive than the turbulent atmosphere of politics. In the discussion of any subject, the value of the views expressed depends upon the first-hand knowledge possessed of it. This is as true of politics as it is of science, though in these two fields rhetoric and fact differ in their influence.

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*Substance of an address delivered at the Royal Institute of International Affairs on Feb. 3.

As the forces of science are in action along the whole front of advancing civilization, it is essential that their strength and disposition should be given full consideration in all social and political campaigns. Their leaders have a right, and a responsibility to their colleagues as well as to other fellow-citizens, to share in the preparation of schemes of operation in which their forces are used. When they enter the field of politics, they possess at least as much general knowledge of the problems involved as is required of representatives of other interests, whether industrial, commercial and financial, or of the armed forces. Their views can have no special authority outside the scientific field to which they have devoted particular attention; but they may justly claim to have been trained to face facts before arriving at judgments, and the value of their public service depends upon their competence to transfer this faculty to the consideration of social and political problems.

One reason why few men of science care to take an active part in politics, is that they do not feel able to effect such a transfer of their trained habits of thought. Birth, social surroundings, and feeling largely determine the side taken in national politics, but all these have little to do with the making of scientific students and discoverers. It is only by applying to political problems the principles of independent inquiry and impartial judgment demanded of investigators in all branches of natural knowledge, that politics can become a science and scientific workers as such can contribute to its advancement. Without this spirit and purpose science and politics are best placed in separate categories.

There is, however, a vast difference between party politics of a national kind and international politics in which the world is the unit and all men are citizens of it, having rights and duties to be wisely adjusted with the object of ensuring progressive development everywhere. This is the field into which the international spirit of science can enter without being regarded as an intruder or becoming involved in controversial national politics. The world is the possession of man, and his endeavour should be to see that its resources, with the powers provided by science, are used for effective development. National boundaries have little relationship to the distribution of natural resources, and less to the needs of modern life. All communities can share in the achievements of scientific discovery and invention, and none can establish an exclusive right to the use of them. Radio communication and aviation have made it impossible for any one nation, or group of nations, to isolate itself from the others, whether near or far. There will be no need for any civilized community to strive for self-sufficiency in a single region, or within a political sphere of influence, when these world powers become agents of international politics. The way may be far to go before national interests will acquire an international outlook, yet the tendency of political groups to become larger gives promise of further expansion into a commonwealth of the chief free peoples of the world.

Such a commonwealth can be secured only by consent, and in it there will be no place for the mastery by force of one race or nation over another. No new world order can have stability unless each nation is free to follow its own lines of cultural development, and does not seek to deprive others of the same liberty. There can be patriotism without arrogance and unity without aggressive imperialism. What is wanted now is not pride of power to make one nation submit to the will of another, and the exercise of it to secure mastery of the world, but pride in a union upon the strength and structure of which each nation depends for freedom and security.

It is only with such a co-operative alliance in mind that the services of science can be used to shape the course of international politics. Knowledge of natural objects and phenomena—their properties, occurrence and range—is not confined to political regions, either in extent or in the use of it. This knowledge is free to the world, and is the foundation upon which the structure of modern civilization is based. It is continually revealing new sources of supply of materials, and power to expand this structure as well as to adorn it. Applied science has provided the means of making the world's abundance available to all peoples. The world is, indeed, self-sufficient to supply the needs of all mankind, and the aim of international politics should be to see that the supply is adjusted according to the need for the use of it.

In the fourth clause of the Atlantic Charter, Mr. Roosevelt and Mr. Churchill expressed the intention of the United States and the British Commonwealth to adopt this principle in a unified political policy. The clause declares that "they will endeavour, with due respect for their existing obligations, to further enjoyment by all States, great or small, victor or vanquished, of access, on equal terms, to the trade and to the raw materials of the world which are needed for their economic prosperity."

This Anglo-American declaration, with the power of two great democracies to implement it, gives an impressive outlook to a new world order. No federation of European States alone could make such a declaration of the effective value represented by the unification of purpose of the British and American Commonwealths. When the principle of freedom of access to the raw materials of the world is conceded by the chief nations of the world, the problems of international politics will be greatly simplified and science will become the chief factor in their solution.

What exists in the world, and what uses can be made of it, are discovered by scientific inquiry and its application. What action is taken upon the knowledge or power thus gained depends upon communities and their governments. Knowledge of natural forces and resources gives no control over them but only an understanding of cause and effect available for human service. Science as such is concerned with the advancement of natural knowledge, and its standards of value are neither ethical nor political. Men of science, therefore, make no special claim to express opinions upon political matters, except in so far as their pursuits affect the welfare of the community, and its repercussions with them. When, however, they give close attention to subjects outside the particular fields they have made their own, their reactions are at least as worthy of consideration as those of other enfranchised citizens.

The view that the sole function of men of science is to study and discover natural facts and principles without regard to the social implications of the knowledge gained can no longer be maintained. It is now widely acknowledged that science cannot be divorced from ethics or rightly absolve itself from the human responsibilities in the use of its powers in economic or political planning. Men of science neglect their duty if they continue to retain the monasterial habits which society commonly assigns to them, and are content to remain isolated from the structure of civilization built up from materials provided by them. It is their obligation as citizens to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown because the powers they have released have not been rightly used in the services of mankind as a whole.

To suggest that the world is a single unit in which all men have certain fundamental rights to live and work, each according to his capacity and needs, may not be practical politics—national or international—yet these are the basic factors in the world's equation. Science and ethics should be able to agree as to the rights of all men to a place on this earth of ours and their duties to the community. Until international politics mean something more than a survey of national claims and actions, with no scientific or ethical principles upon which to arbitrate, expediency and not equity must continue to determine its judgments.

Before any worthy world order can be established, the fundamental rights of men and communities must be defined and acknowledged by the democracies which promote it. The Anglo-American Charter represents the beginning of the infusion of this spirit into the working of world affairs. The outlook of international politics is vastly extended by this Charter, and an instrument has been constructed which gives new meanings to the dimensions of time and space on a changing world. It recognizes by implication that the goal of a world commonwealth can be brought into sight and gives hope that the promise of a dream is not beyond fulfilment.

It was in this spirit that a Declaration of the Rights of Man was drafted a year ago by a committee under the chairmanship of Lord Sankey and submitted to public discussion. The opening paragraphs of the introduction to the Declaration may be appropriately reproduced here because they state world conditions differing from those with which international politics have hitherto had to deal. The paragraphs read as follows:

"Within the space of little more than a hundred years there has been a complete revolution in the material conditions of human life. Invention and discovery have so changed the pace and nature of communications round and about the earth that the distances which formerly kept the States and nations of mankind apart have now been practically abolished. At the same time there has been so gigantic an increase of mechanical power, and such a release of human energy, that men's ability either to co-operate with or to injure and oppress one another, and to consume, develop or waste the bounty of Nature has been exaggerated beyond all comparison with former times. This process of change has mounted swiftly and steadily in the past third of a century, and is now approaching a climax.

"It becomes imperative to adjust man's life and institutions to the increasing dangers and opportunities of these new circumstances. He is being forced to organize co-operation among the medley of separate sovereign States which has hitherto served his political ends. At the same time, he finds it necessary to rescue his economic life from devastation by the immensely enhanced growth of profit-seeking business and finance. Political, economic and social collectivisation is being forced upon him. He responds to these new conditions blindly and with a great wastage of happiness and well-being."

The object of the Declaration was to assemble and proclaim fundamental and inalienable rights of man as a species living upon the planet Earth, and with powers of conquest over agencies—natural or social—which obstruct his advancement. Science and the humanities can meet on common ground in an endeavour to make a charter of this kind represent elements which enter into human reactions and should be regarded almost as commandments for the guidance of international policies. When agreement has been reached upon the essential human needs and rights declared in such a charter, a very promising nucleus will have been created upon which scientific and ethical principles can crystallize. Without a foundation of this kind, conciliation of conflicting interests and political expediency will determine the influence and actions of leagues, unions, councils and courts, and there will be no fixed star by which to shape the courses of ships in the stormy seas of international politics.

Since the outbreak of the conflict in which all peoples of the world are now directly or indirectly involved, many declarations have been made of principles expressing the needs and aims of all men. They all have much in common, and from them it should be possible to construct fixed standards in which the rights of nations are given world values and the welfare of the whole community of mankind is the concern of international politics. However far distant we may be from the effective application of such basic principles, conditions of life to-day demand the formulation, by common consent, of a charter in which all communities will have world rights, relationships and responsibilities. There can be no unified political, economic and social order unless schemes of reconstruction are conceived in this spirit, with full knowledge of the primitive instincts of man and the lag between them and the powers which science have given him.

The three chief principles of inter-State intercourse, on which international law is based, are said with authority to be:

(1) Recognition of each other's existence and integrity as States.

(2) Recognition of each other's independence.

(3) Recognition of equality, one with another, of all independent States.

International law may narrate these principles, but international politics have made a mockery of them. A bewildered world finds itself deprived of all these 'recognitions', and seeks new fundamental truths to satisfy its outlook. The so-called laws of Nature are only generalizations which have to be revised when cases not covered by them are brought before the court of science. International politics has to adopt a similar attitude towards the evidence presented to it, and international statutes should not be limited to the relationships of one sovereign State to another, but of every State to all others.

In the realm of the humanities, as in that of the natural sciences, the closer the approach of a principle to fundamental truth, the longer will it survive. All peoples of the world have certain attributes in common, and all high religions teach the observance of certain ethical principles. When these principles have been analysed and collated, a sound basis will be secured for the constitution and judgments of a court of international politics, and the goal of world unity will come into view. Science can usefully combine with politics to attain this end.

GROWTH AND DETERMINATION IN THE DEVELOPMENT OF DROSOPHILA

By Dr. C. H. WADDINGTON
Department of Zoology, and Strangeways Research Laboratory, Cambridge

It is usually held that development in the Diptera is typically 'mosaic'. The determination of larval characters is known to take place at a very early stage (reviewed, Richards and Miller[1]), and that of the imaginal characters is not supposed to be delayed more than a few hours after fertilization. The evidence on which the latter part of this statement is based is not extensive. Geigy[2] observed the development of defects in Drosophila flies which had been injured by ultra-violet puncture shortly after fertilization, and Howland and Child[3] obtained similar results with mechanical injuries. Pursuing another line of experimental analysis, the workers with the transplantation technique of Beadle and Ephrussi have shown that the imaginal buds of the eye region, isolated from young larvæ, are able to develop well-formed ommatidia when isolated in the body cavity of host animals. Steinberg[4] has pushed back the earliest time from which successful development is possible to twenty-four hours after hatching, before which the buds are too small to be handled.

The history of the analysis of amphibian development is a warning of the danger of considering such defect or isolation experiments as satisfactory means of discovering the developmental potentialities of tissues; many cases are known in which, although defects are not made good, or 'self-differentiation' occurs after isolation, the tissues have later been shown to be still labile and capable of being deflected into quite a different developmental path. Some recent work on Drosophila indicates that a similar error of interpretation has been made in respect of the imaginal buds of that form.

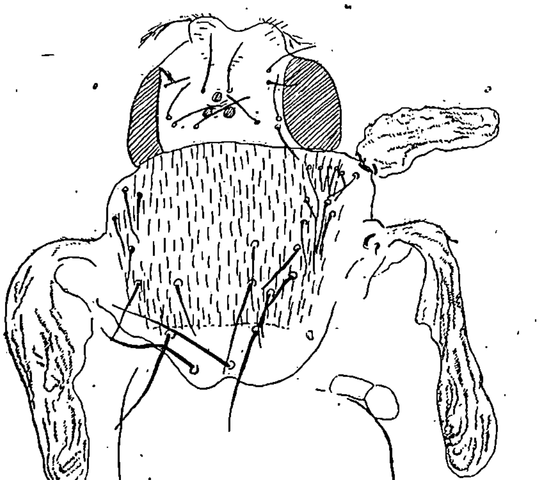

Fig. 1.
DROSOPHILA ADULT, X-RAYED AS LARVA AGED 66-72 HOURS AFTER LAYING. NOTE REDUPLICATION OF WING-BEARING REGION OF THORAX ON RIGHT SIDE.

Drosophila larvæ were treated with heavy doses (7,000 r-units) of X-rays. Pupæ aged more than twenty-four hours after puparium formation when irradiated showed little or no morphological effects. Irradiation in the period between twelve hours before and eighteen hours after puparium formation caused the death of large numbers of individual cells. This led to the cessation of morphogenesis in the wings at an early stage, but its most marked effects were on the chætal elements. Large numbers of bristles, both macro- and micro-chætæ, were removed; the macro-chætæ were more strongly affected towards the beginning of the period and the micro-chætæ towards the end. In Drosophila each bristle is accompanied by a socket, the complete apparatus being formed from a group of two cells. The proportion of cases in which both cells were removed was much greater than would be expected if the only effects were the direct results of ionizations; one must conclude that the two cells influence one another during development, and that the death of one is likely to prevent the differentiation of the other.

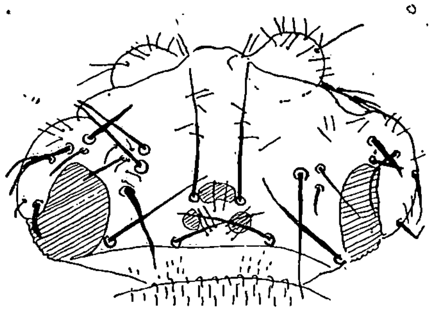

Fig. 2.
X-RAYED AS 72-90 HOUR LARVA. NOTE PALPS ON BOTH EYES.

The most interesting results were obtained with irradiations of larvæ aged 60–90 hours after laying, that is, in the early part of the third instar. The mortality was very high, and no flies succeeded in emerging from the pupa cases; those which did develop had to be freed from their pupal integuments by dissection. In most of them, various organs were found to be hypertrophied; and the increases in size of the parts were often accompanied either by reduplication or by the development of tissue characteristic of some other part of the body. The antennæ were little affected, although in one case the base of the arista was transformed into a somewhat leg-like material. The eyes, on the other hand, were very frequently abnormal; they were usually larger than normal, and the anterior dorsal region was transformed into a palp bearing typical bristles, and this might be lengthened into a band cutting the whole eye into two parts, which should probably be regarded as two separate eyes developed by reduplication. In a few cases the palp had the character of an antenna. Overgrowth in the thorax led either to duplication of some regions (for example, the scutellum or the wing-bearing region) or merely to the formation of an irregular and lumpy thorax. Within the wing itself, extra lobes might be formed, or part of the wing might be converted into a tissue resembling the normal body surface. The legs were highly abnormal, often sharply bent and very swollen.

Larvæ much younger than sixty hours at irradiation gave rise to completely normal adults. We therefore find that the developmental fate of imaginal buds can be changed as late as ninety hours after laying, while earlier than sixty hours determination is so indefinite that complete regulation is still possible. The agent by which these changes have been produced (7,000 r-units of X-rays) is, of course, a drastic one, but the effects produced cannot be considered to be merely injuries (for example, the conversion of eye material into antenna). We must conclude that changes in developmental fate can be caused by factors which can be produced, under the influence of X-rays, by the tissues themselves. It becomes then a reasonable hypothesis to suppose that determination in normal development is brought about by similar tissue interactions; and one is inevitably reminded of the organizer phenomena in vertebrate embryology.

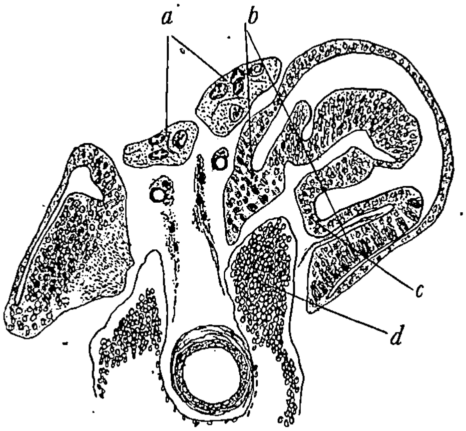

Fig. 3.

SECTION THROUGH IMAGINAL BUD OF RIGHT EYE IN LARVA X-RAYED WHEN AGED 72–90 HOURS. *a*, WEISSMAN'S RING; *b*, EYE-FORMING REGION OF IMAGINAL BUD; *c*, FOLD IN BUD, WHICH WILL GIVE RISE TO PALP; *d*, ANTERIOR PART OF BRAIN.

The nature of the determining factors produced by the irradiation cannot be stated with certainty, but it is clear that changes in growth are intimately involved with them. This is so not only in the cases where an obvious hypertrophy has occurred as in the reduplicated organs, but also in connexion with the palp-formation in the eyes. In the cephalic imaginal buds of irradiated larvæ just before pupation a fold can often be found in the eye-forming region, and it seems certain that this is (*a*) a result of an overgrowth of this region, and (*b*) the forerunner of a palp. An exactly similar appearance can be found in the imaginal buds of larvæ homozygous for the gene *ophthalmopedia* (stocks of which I owe to the kindness of Dr. C. Gordon), which causes the formation of eye-palps very similar to those in the irradiated flies.

There is evidence from another quarter which strongly suggests that abnormalities of growth, by causing irregularities of the folding of the imaginal tissue, eventually bring about changes in differentiation. Several genes are known which affect the legs of Drosophila; *dachs* and *fourjointed* shorten the legs and reduce the number of tarsal joints to four, *dachsous* produces somewhat irregular short legs, and *comb-gap* (derived from an *S E-S/cg l* stock obtained from Muller; possibly two closely linked genes are concerned in the variable effects noted here) causes the legs to be irregularly swollen, sometimes very considerably. All these genes have secondary effects; that of *comb-gap* is the production of a gap in the fourth longitudinal vein on the wings, but in the others the effects clearly involve growth, the wings being reduced in size and made rounder, the thorax made short and thick, etc. The leg effects, which are the most easily recognized, can easily be detected in the imaginal buds at the time of pupation. None of the genes produces any changes in tissue differentiation when alone, nor do most of the compounds; homozygous *dachs-fourjointed* look the same as *dachs*, while in *dachsous-combgap* the leg buds are highly abnormal and frequently, owing to faulty eversion and failure of the subsequent contraction, produce legs more like flippers than normal Dipteran limbs. But very different phenotypes are produced by *dachs-dachsous* or *fourjointed-combgap*. In both cases reduplications and changes in differentiation are quite frequent; the antennæ are often double, and parts of the eye may be converted to antennæ (five antennæ on one head is the maximum number so far recorded), the blade of the wing may have extra lobes, or be duplicated in part, the whole wing region may be converted into typical body-surface, the legs may terminate in arista-like tufts, etc. In the case of the eye, abnormal folding, presumably the forerunner of antenna-formation, has been detected in the imaginal bud.

We have then two cases of two genes, each of which affects the growth of many parts of the fly, producing when in combination effects not only on growth but also on the type of differentiation undergone by the various imaginal buds. It is scarcely plausible to suggest that several different morphogenetic substances are involved, and that the genes when in combination, but not when alone, affect all these substances by some mechanism other than through their growth-effects. After accepting the evidence of the irradiation experiments that Drosophila imaginal buds remain incompletely determined throughout the greater part of larval life, much the simplest hypothesis is to suppose that their determination can be affected by abnormal folding, which can be produced by irregularities in growth.

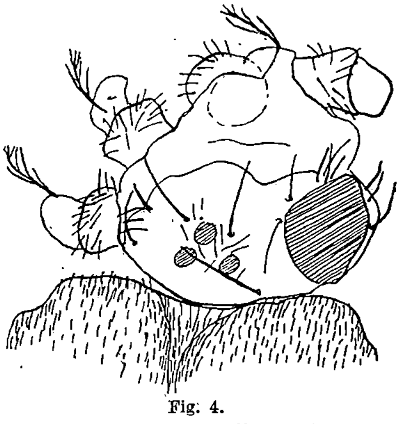

Fig. 4.

HEAD OF ADULT OF GENOTYPE *cg c fj px sp* (THAT IS, *combgap-fourjointed*). NOTE CONVERSION OF EYE TO ANTENNA, AND SWELLING OF THORAX.

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[1] Richards, A. G., and Miller, A., *J. N.Y. Entom. Soc.*, **45**, 1 (1937).

[2] Geigy, R., *Arch. Entw.-mech.*, **125**, 406 (1931).

[3] Howland, R. B., and Child, G. P., *J. Exp. Zool.*, **70**, 415 (1935).

[4] Steinberg, A. G., *Gen.*, **26**, 325 (1941).

OBITUARIES

Prof. T. Levi-Civita, For. Mem. R.S.

TULLIO LEVI-CIVITA was born at Padua on March 29, 1873, son of a renowned advocate who was mayor of Padua and senator of the realm. He entered the University of his native city where, after studying with Veronese and Ricci, he graduated in 1894; four years later he was appointed to the professorship of mechanics at Padua. In 1914, he married Sig.na Libera Trevisani, one of his former students. In 1918, he was called to the University of Rome, where he occupied the chair of theoretical mechanics until his dismissal, in 1938. He died in Rome, after a lingering illness, on December 29.

Levi-Civita was unquestionably one of the best-equipped and most versatile mathematicians of our time: primarily an applied mathematician, he had been strengthened by the magnificent discipline of the Italian geometrical school which, apart from inspiring his valuable researches in differential geometry proper, furnished him with powerful weapons for attacking the problems of physical science. In the latter field his interests were all-embracing, and he made important contributions to such diverse topics as potential theory, wave motion, hydrodynamics, analytical dynamics, relativity theory, thermodynamics and theoretical physics, in particular, quantum mechanics. On the more technical side, where he was often called into consultation by his colleagues, he studied various complex problems in electrodynamics, elasticity and strength of materials, devising practical methods of calculation which have since proved their worth.

In the field of pure mathematics his interest was scarcely less extended. One may mention that his first papers were on the distribution of prime numbers and the foundations of geometry; afterwards, as a natural outcome of his other work, he was drawn to the study of conformal representation—in which, as regards its applications, he was one of the pioneers—and the theory of partial differential equations. He also made one of the earliest contributions to the theory of functions of two complex variables: all this, be it observed, in addition to the work in differential geometry for which he is chiefly celebrated.

At this point it is interesting to recall that Levi-Civita's teacher, Ricci, was once refused a Royal Prize for his work on tensor calculus, on the ground that it could not conceivably be of use to anyone, even a differential geometer. An apt comment on this verdict was later to be provided by Einstein's general theory of relativity, the foundations of which were actually laid in a great memoir by Ricci and Levi-Civita themselves. However, both before and after the tensor calculus had become useful, Levi-Civita was its most assiduous cultivator; and during a long period the *Rendiconti* of the Lincei were enriched by a series of notes on differential geometry, treated by its methods. These researches culminated in the memoir of 1917, introducing the concept of parallelism with which his name is associated, and constituting perhaps his surest title to fame.

The fecundity of such a great and varied production is amply proved by the number of disciples who have followed in its wake and the schools which have found inspiration in its conceptions. This multiform activity was centred, not in the published work, but directly in its creator. For more than forty years Levi-Civita was one of Italy's greatest teachers, drawing to himself students from all over the world, aiding and encouraging them with inexhaustible patience and generosity. Part cause, part effect of these contacts was a knowledge of mathematical literature that was truly encyclopædic; until the end Levi-Civita maintained his grasp of nearly the entire range of contemporary mathematics, and with his reading went a vast scientific correspondence, to which he attended with his customary diligence and zeal. As a writer of text-books, Levi-Civita is mainly known in Great Britain by the English version of his work on the tensor calculus; but it should be added that his comprehensive treatise on mechanics (written in collaboration with Amaldi) is the leading Italian work on the subject. A course of lectures on differential systems and wave propagation has also been published in book form.

Nevertheless, however splendid his achievement, to those who have known him it must always take second place to the man himself. This cannot often be said of a mathematician; not to say it of Levi-Civita would be unjust to his memory. The exquisite courtesy, the humility carried to such lengths that it might have been judged hypocrisy in another, were typical manifestations of his generous spirit. Many will have received some special token of his kindness; many more will have enjoyed his hospitality, or carry with them the indelible souvenir of his presence in the lecture room: the characteristic figure on the rostrum expounding, with overwhelming enthusiasm, some point in the theory of mechanics or differential equations.

Levi-Civita was the recipient of many academic distinctions and honorary member of numerous societies, in particular, of almost all the scientific academies of Italy and Germany. In 1938, when dismissed from his post in consequence of the racial legislation, he was also expelled from the latter, with the sole exception of the Pontifical Academy of Sciences. In Italy itself his death occasioned no official response, save within the Vatican City, where, at a recent session of the Pontifical Academy, he was duly commemorated. His last years had been overcast by an ever-deepening pre-occupation with the future of his country; it is easy to imagine how so liberal a mind, coloured with the Garibaldian traditions of his early education, viewed the progressive decay of international relations and ethical standards. With his death there has passed away a man of science and an Italian whom we can ill afford to lose and whom we shall not soon see replaced.

L. ROTH.

Dr. A. K. Chalmers

WE regret to announce the death at the age of eighty-six of Dr. Archibald Kerr Chalmers, one of the most eminent contemporary epidemiologists. He was born at Greenock in 1856, and received his medical education at Glasgow, to which he remained faithful, and qualified in 1879. After holding resident appointments at the Glasgow fever hospital, he was appointed medical officer of health for that city in 1892, and held the office until his retirement in 1925. Throughout his life he showed a remarkable administrative and literary activity. During his term of office he was busily engaged in the management of acute infectious diseases. Besides Chalmers's principal work entitled "Health of Glasgow, 1818–1925: An Outline" (1930), which may be regarded as a classic, he was also author of addresses on several sanitary subjects, such as "Vital Statistics of School Ages" (1898), "The House as a Contributory Factor in the Death-Rate" (1913), "Economy in Food during the War" (1915), and in 1924 delivered the Watsonian Lectures before the Faculty of the Royal College of Physicians and Surgeons of Glasgow on "Epidemic Diseases of the Central Nervous System".

Chalmers received many well-merited honours, such as those of honorary LL.D. of Glasgow, honorary fellowship of the Royal Faculty of Physicians and Surgeons of Glasgow and the Médaille du Roi Albert. He was president of the Section of Epidemiology and State Medicine of the Royal Society of Medicine in 1920.

J. D. Rolleston.

We regret to announce the following deaths:

Sir Robert Chapman, C.M.G., professor of engineering in the University of Adelaide during 1907–37 president of the South Australian School of Mines aged seventy-five.

Sir Robert Elliott-Cooper, formerly president o the Institution of Civil Engineers, on February 16 aged ninety-seven.

Prof. Max Kriss, associate professor of animal nutrition in Pennsylvania State College, aged fifty-two.

Dr. Paul S. McKibben, professor of anatomy and dean of the School of Medicine of the University of South California, known for researches on the nervous system of Amphibia, aged fifty-five.

The Very Rev. Sir George Adam Smith, F.B.A., Principal of the University of Aberdeen during 1909–35, on March 3, aged eighty-five.

NEWS and VIEWS

Prof. A. C. Hardy, F.R.S.

Prof. A. C. Hardy, whose appointment to the regius chair of natural history in the University of Aberdeen has just been announced, is well known for his distinguished work on plankton problems. The development of the strikingly new methods which he has evolved in this work may be traced to the time when, as a member of the scientific staff of the Ministry of Agriculture and Fisheries, he introduced a simple plankton recorder made to assist fishermen in the location of herring shoals. Later, as second-in-command on the scientific staff of the Discovery Committee, he spent some two years in the Antarctic in the R.R.S. *Discovery*, and here had opportunities for the invention of a much more elaborate instrument designed to give a continuous record of the plankton, while being towed at full speed. Undeterred by initial failures he finally perfected this instrument, and from the new department which he later founded at University College, Hull, he inaugurated comprehensive plankton surveys of the North Sea with plankton recorders used from commercial vessels. This work, with Government assistance, developed rapidly until the War made it necessary to discontinue operations at sea; a substation was opened at Leith and a number of very valuable reports have appeared in the *Hull Bulletins of Marine Ecology*.

It is satisfactory to learn that Prof. Hardy's fruitful work on the North Sea plankton will continue. On taking the chair at Aberdeen he will become honorary director of oceanographical investigations at University College, Hull, and the oceanographical work of that department will henceforth be in charge of Mr. C. E. Lucas, the senior member of his research staff. In addition to this profitable work on plankton, Prof. Hardy has most ingeniously adapted oceanographical methods to the study of insect distribution. Using devices similar to those employed under water, he has flown light nets, fitted with opening and closing mechanism, from kites; and in this way has shown that many species of insect, including agricultural pests, can be brought to Great Britain in the upper layers of the air.

Royal Society of Edinburgh

The following have been elected ordinary fellows of the Royal Society of Edinburgh:

Prof. T. Alty, Department of Applied Physics, University, Glasgow; Mr. R. E. Cooper, curator, Royal Botanic Garden, Edinburgh; Dr. James Cossar, lecturer in technical mathematics, University, Edinburgh; Prof. T. Dalling, director, Ministry of Agriculture's Veterinary Laboratory, Weybridge; Dr. S. C. Das, lecturer in pharmacology, Robertson Medical School, Nagpur, C.P., India; Dr. Andrew Davidson, chief medical officer, Department of Health for Scotland; Mr. Arthur Earland, Edinburgh; Dr. G. H. Edington, Glasgow; Mr. A. H. Gosling, assistant commissioner, Forestry Commission, Scotland; Prof. A. Gray, Department of Political Economy and Mercantile Law, University, Edinburgh; Dr. R. A. R. Gresson, Department of Zoology, University, Edinburgh; Dr. K. E. Grew, lecturer in physics, Heriot-Watt College, Edinburgh; Dr. W. A. Harwood, superintendent, Meteorological Office, Edinburgh; Dr. J. R. M. Innes, pathologist, Biological Laboratories, I.C.I. (Dyestuffs) Ltd., Hexagon House, Manchester; Dr. Daniel Lamont, surgeon, Glasgow Royal Cancer Hospital, and Glasgow and West of Scotland Radium Institute; Dr. W. M. Levinthal, bacteriologist, Royal College of Physicians Laboratory, Edinburgh; Dr. James Macfarlane, medical liaison officer, Scottish Office, London; Mr. Peter N. McFarlane, Glenordie, Stanley, Perthshire; Dr. J. F. Malcolm, lecturer in bacteriology, West of Scotland Agricultural College, Glasgow; Prof. S. T. Mayow Newman, Reid School of Music, University, Edinburgh; Dr. Jocelyn Patterson, lecturer in biochemistry, Charing Cross Hospital Medical School; Dr. J. R. Peddie, secretary, Carnegie Trust for the Universities of Scotland; Mr. Douglas M. Reid, senior biology master, Harrow School; Prof. W. J. B. Riddell, Department of Ophthalmology, University, Glasgow; Dr. J. D. Robertson, Courtauld Institute of Biochemistry, Middlesex Hospital, London; Dr. William Scott, Fryern Hall, Bridgewater, Somerset; Mr. Charles Strachan, lecturer in applied mathematics, University, Liverpool ; Dr. Joseph Tait, resident secretary in Scotland, Pharmaceutical Society ; Mr. D. R. Wilson, bacteriologist, Moredun Institute, Animal Diseases Research Association, Gilmerton, Edinburgh.

The Council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1939–41 jointly to Prof. E. T. Copson, University College, Dundee, and to Prof. W. H. McCrea, Queen's University, Belfast, for their papers in the *Proceedings* of the Society within the period of the award, and in recognition of their valuable contributions to the theory of Riemannian space and general relativity.

The Neill Prize for the period 1939–41 has been awarded jointly to Dr. P. C. Koller, Institute of Animal Genetics, University of Edinburgh, for his contributions to cytology ; and to Dr. W. J. McCallien, Department of Geology, University of Glasgow, for his contributions to the tectonic geology of the Scottish Highlands.

Philosophy of the Physical Sciences

IN his recent presidential address to the Royal Society of Edinburgh on "Some Disputed Questions in the Philosophy of the Physical Sciences", Prof. E. T. Whittaker discussed the problem raised by the Greeks and at the present time vigorously debated by Eddington, Jeffreys, Milne, Jeans, Dingle and others, on the respective shares of reason and observation in the discovery of the laws of Nature. He recalled that the Greeks considered that geometry could be built up completely apart from observation, but that Aristotle at least (and much later Aquinas) held that other sciences must be built on experience. Later progress showed that geometry also must be regarded as a branch of experimental knowledge, and from the time of Newton until now, the principle that science rests fundamentally on observation and experiment has been unchallenged. Now, however, certain thinkers—notably Milne and Eddington—hold that the laws of Nature can be derived without recourse to observation. Prof. Whittaker points out that many important branches of physics can be deduced from single "postulates of impotence" ; for example, the whole of relativity theory follows from the postulate that it is impossible to detect absolute motion. Such postulates are not the direct result of experiment, though they are generalizations from experiment. Milne's "cosmological principle" is in form a postulate of impotence, but it is assumed without experimental support. Eddington's "epistemological principles", however, are different, but Prof. Whittaker is not convinced that they have any basis outside experience. His verdict on Eddington's claim is : "Not Proven".

The concentration into postulates of impotence of the experimental contribution to physical laws is a very suggestive generalization, and it is an interesting conjecture that the whole of physical law might ultimately be derived by reason from a single postulate of impotence. At the same time it would be a mistake to suppose that anything significant can come out of a pure negation. A postulate of impotence is indebted to experience not only for failure to violate it but also for an indication of the positive thing which in the stated circumstances it denies. The impossibility of spontaneous passage of heat from cold to hot bodies implies the fact of experience that heat can pass between bodies ; the denial of absolute motion would be without meaning if we had no experience of relative motion ; and so on. It is a pity that Prof. Whittaker's address was prepared before Eddington's recent change of front. In the "Philosophy of Physical Science" he wrote : "For the truth of the conclusions of physical science, observation is the supreme Court of Appeal" (p. 9), and accepted the statement that physics is "the rational correlation of experience" (p. 185). In NATURE of October 25, 1941, however, he stated, in reply to the objection that the supreme Court of Appeal might decide against the rationally derived laws, that "the fundamental ('inviolable') laws are not assertions about experience". It appears, therefore that Prof. Whittaker has been analysing a superseded claim.

Science as a Force of Freedom

THE value of science as a force of freedom was emphasized by Mr. G. B. Lal in a recent address to the New History Society, New York. The power of science is unique. Great men of science have world-wide influence. But they have achieved such influence without the use of the slightest violence or fraud. People have killed each other for religion ; but not for science. In science there is a peculiar and most important pattern of freedom. Science develops only when the scientific worker has enough social power to enable him to do his work utterly unhampered. Also, every development in science releases new forms of social energy. Most people respect science because of its practical importance, as shown by the machines of scientific inventors, the conquest of diseases, the piling up of profits in industries, the production of military weapons, rapid transportation and communication. But the most important thing about science is its method. The scientific method is the most efficient use of human intelligence for the discovery of truth.

Physics of a Transmission Line

PROF. W. M. THORNTON has published a thought-provoking paper with the above title (*J. Inst. Elec. Eng.*, **88**, Pt. II, No. 6, Dec., 1941) in which he deals with the fundamental and, in part, unknown field of electromagnetic study underlying the many technical and economic problems entailed in the design, construction and operation of electric transmission lines. He pays special attention to the electromagnetic mechanism by which electric and magnetic stresses in space combine so that the energy of electric strain passes continuously along the insulating medium around the wires. Remarking that this, the Poynting flux flow, is the least known of the physical actions in transmission, Prof. Thornton discusses the transfer of potential energy along a transmission line by strain of the insulation, extending the theory to the supply of energy to electric lamps, heaters and rotating machinery. Following a lucid explanation of Poynting's theorem, physical analogies are given to the resistance, inductance and capacitance of a transmission line, resistance being regarded as the coefficient of dissipation of energy, inductance as inertia, and capacitance as elasticity ; an invisible shaft of energy which would be perfectly rigid in the absence of inductance and capacitance rotates about the conductors of a three-phase system at the supply frequency.

Suggesting that there may still be engineers who regard the purity of the copper of their machines or cables as more important than insulation quality, the paper proceeds to a discussion of the function of insulation and the complex nature of corona, pointing out the limiting influence of the latter on voltage, while emphasizing that from the same aspect moisture effects are more important than corona. Prof. Thornton closes with a brief mention of the mechanical design of insulators, remarking that the complex physical stresses, electrical and mechanical, in a suspension insulator form a difficult three-dimensional problem which may well repay further investigation.

Technical Developments in Broadcasting

IN his chairman's address to the Wireless Section of the Institution of Electrical Engineers (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 13; 1942) H. Bishop of the B.B.C., in reviewing the general trend of progress up to the outbreak of hostilities, gave first an outline of the underlying principles involved in the acoustic design of studios and mentioned some of the difficulties associated with the microphone. Programme input equipment and the control and measurement of the volume of broadcast programmes were discussed, special mention being made of the war-time application of sound recording and reproduction by the B.B.C. Tribute was paid to the Post Office in connexion with the use of telephone networks as music, control and television circuits. Transmitter design, modulation and frequency control and power plant received considerable attention. The influence of ionospheric storms on short-wave propagation was discussed, and a section included on the application and control of frequency measurement stations. The address closed with a reference to post-war receivers, suggesting that greater measures of standardization and reliability are needed to achieve the success so dependent on public interest.

Meteorology of Rhodesia

THE Meteorological Report of the Rhodesia Meteorological Service for the year ended June 30, 1940, has the signature of R. A. Jubb, acting chief meteorologist, owing to the appointment of the chief meteorologist, Mr. N. P. Sellick, to the post of deputy director of meteorological services of Southern Africa, with his headquarters at Pretoria. Since the period covered by the report includes the outbreak of war, to the normal activities of the service was added the work of reorganization to meet naval and military war-time requirements and the restrictions imposed by the censorship on the publication of weather reports and forecasts. In consequence of this handicap there are few new developments to record, but on the other hand the collection of meteorological statistics, including hourly readings of various instruments at the main observatories, was maintained without any general interruption, and continued to prove of great value to engineers and to various industrial enterprises. These statistics, in tabular form, occupy the greater part of the report. The addition of thermographs to many climatological stations was found to be useful both in tracing the travel of weather systems and as a check on the readings of thermometers. The seasonal forecast of the general rainfall by a formula taking into account the values of various meteorological elements at 'action centres' in distant regions was continued. A deficiency of 4·8 in. was predicted for 1939–40, but an excess of 3·3 in. was experienced. In the eleven years for which the results of such forecasts are available there were only two other comparable failures, whereas successful predictions were made in sever years, the most notable being an almost exact pre diction of the outstandingly heavy rainfall of 1938–39, which amounted to an excess of 12·2 in. compared witl the predicted excess of 11·8 in. The utility of these forecasts now appears to have been firmly established.

Social Implications of Dietetics

ADDRESSING the Rugby Branch of the Association of Scientific Workers on February 19 on the "Social Implications of Dietetics", Prof. V. H. Mottram examined the possibility of securing the basic dietetic essentials for healthy living in present circumstances. He stated that an investigation in Leicester as to the present cost of providing as close as possible an approximation to the British Medical Association estimate would be 11*s*. 3½*d*. per head per week. He compared with this the allowances being given for evacuated children and the dependants of Service men. Prof. Mottram suggested that only by special provision of family allowances on a fairly generous scale will it be possible to ensure that children will receive their needful intake of food essentials, and emphasized that the logic of free education leads on to the provision of free food for children and adolescents.

The future agricultural policy of Great Britain, Prof. Mottram said should be directed to growing more 'protective' foods—such as dairy foods and market garden produce—for which the soil and climate are best fitted. In this he was sustained by the agreement of Sir John Russell, Sir John Orr and Mr. A. G. Street. On the question of health in war-time, while pointing out that the tuberculosis-rate is rising, he agreed that there seems to be no deterioration and even some improvement in general health. This he attributed, not to any beneficial effects of rationing, but to better and more food being consumed by the millions now employed who have previously been unemployed, and by the millions now in the Army who are better fed than before. His conclusion was that little can be done in war-time to improve diet, though the provision of concentrates might be helpful.

Banana Research in Trinidad

PROF. C. W. WARDLAW, Barker professor of cryptogamic botany in the University of Manchester, read a paper on banana research in the Imperial College of Tropical Agriculture, Trinidad, at the Royal Society of Arts on February 24. After emphasizing the merits of the Jamaica banana or Gros Michel as a commercial variety, Prof. Wardlaw discussed its susceptibility to Panama disease, caused by the soil-borne fungus *Fusarium oxysporum cubense*. A three-fold research scheme to deal with this was organized by the College in collaboration with the Royal Botanic Gardens, Kew. Prof. Wardlaw then indicated some of the practical and scientific results obtained from this research scheme. Hybridization experiments and storage investigations were also described. Prof. Wardlaw was closely associated with these researches while on the staff of the Imperial College of Tropical Agriculture. Readers will recall the excellent series of three articles by him on the banana in Central America in NATURE (147, 313, 344, 380; 1941); and now they are recommended to read the present address, which covers the whole field and which will be published in due course in the *Journal of the Royal Society of Arts*.

Menace of Typhus

ACCORDING to an editorial in the *Medical Officer* of February 21, the prospect of typhus reaching Great Britain is more than likely, but the spread of the disease can be as certainly checked by extermination of lice as smallpox can be by vaccination. The distribution of typhus at the present time is mainly confined to Spain, North Africa and Eastern Europe. In October and November 1941 less than twenty cases a week were noted in the civil population of Germany. On the other hand, the article states that if the Russian counter-offensive becomes a rout and Germany is invaded, it would be impossible to prevent the disease spreading to the civil population of Germany and to all the occupied countries in Europe. Unless, however, the Germans invade Britain *en masse*, this country is not likely to be over-run by typhus. No case of typhus in Great Britain has been recorded for more than ten years, and there have been only rare and small outbreaks for the past half-century, in contrast with Ireland where there is an endemic focus in Connaught. The unlikelihood of the disease gaining a foothold in Great Britain is increased by the uncertainty of the head louse conveying the disease, the comparative rarity of body lice in our population and the comparative facility of body delousing.

University Grants

SIR KINGSLEY WOOD has announced in a written reply to a question in the House of Commons that the Government is to maintain its grant for 1942 to the universities at its existing level. He recalled that, in view of the vital part played by the universities in the life of the community, the importance of maintaining so far as possible standards of university education and the essential contribution of the universities towards the national effort, the Government decided early in 1941 to keep the universities grant at the 1939 and 1940 figure, namely, £2,149,000. The impact of the war on university finance has so far been less severe than was expected. On the other hand, while the repair of physical damage resulting from enemy action can be dealt with under the existing war damage legislation, the repair of war damage is by no means the only problem, involving large demands on university funds, which will arise on the conclusion of hostilities. In reaching a decision, the Government had in mind these points, and had also considered a report from the University Grants Committee reviewing the whole situation.

University of London

THE degree of D.Sc. has been conferred on the following: Dr. G. W. Scott Blair (National Institute for Research in Dairying); Dr. A. H. Cook (Imperial College of Science and Technology); Mr. C. L. Hewett (Royal Cancer Hospital (Free) and the Sir John Cass Technical Institute); Mr. Alexander King (Imperial College of Science and Technology); Mr. M. A. Phillips (Battersea Polytechnic); Dr. Eugene Rothstein (Imperial College of Science and Technology); Dr. Frank Smithson (Birkbeck College); Prof. F. R. Winton (University professor of pharmacology in University College).

The William Julius Mickle Fellowship has been awarded to Prof. Alexander Fleming, professor of bacteriology in St. Mary's Hospital Medical School.

Regulations have been adopted for the recently instituted certificate of proficiency in radio-physics.

Scholarships in Electrical Engineering

APPLICATIONS, which must be received not later than April 15, are invited for the following scholarships awarded by the Institution of Electrical Engineers (Savoy Place, London, W.C.2): *Duddell Scholarship* (value £150 per annum, tenable for three years): Open to British subjects under nineteen years of age on July 1, 1942, who have passed the matriculation examination of a British university or an examination exempting from matriculation and who wish to take up a whole-time day course in electrical engineering; *Silvanus Thompson Scholarship* (value £100 per annum and tuition fees, tenable for two years, renewable in approved cases for a third year): For works employees who are the sons of parents of limited means. Open to British subjects under twenty-two years of age on July 1, 1942, who (*a*) have served a minimum apprenticeship (or its equivalent) of three years at an approved electrical engineering works, and (*b*) in addition to having taken full advantage of available opportunities for technical education, have acquired a marked degree of skill, and/or shown evidence of originality. The successful candidate will be required to take up a whole-time day course in electrical engineering at an approved university or technical college; *William Beedie Esson Scholarship* (value £120 per annum, tenable for two years, renewable in approved cases for a third year): For works employees who are the sons of parents of limited means. Open to British subjects under twenty-two years of age on July 1, 1942, who have served a minimum apprenticeship (or its equivalent) of three years at an approved electrical engineering works. The successful candidate will be required to take up a whole-time day course in electrical engineering at an approved university or technical college.

Announcements

THE Medical Research Council has appointed Prof. A. W. M. Ellis, formerly University professor of medicine at the London Hospital, to a whole-time position on its scientific staff as director of research in industrial medicine. The investigations to be undertaken by Prof. Ellis and his assistants will in the first instance be directed to problems of industrial toxicology which are of special importance during the War.

FOR the second year, the Rockefeller Foundation has made a grant to enable the Royal Society to assist scientific societies and associations to meet the financial difficulties involved in the publication at the present time of scientific journals. This generosity, which last year benefited a number of bodies, will be widely appreciated.

THE Royal Society of Arts has awarded the annual Thomas Gray Memorial Trust Prize of £50, for an invention advancing the science or practice of navigation, to Mr. T. E. Metcalfe, of Windsor, for the seaman's protective suit devised by him. This suit, which, when not in use, folds into a compact bundle, weighing about 3 lb., forms a complete covering of water- and wind-proof material to be put on when a shipwrecked person reaches a lifeboat or raft. It is being provided by the Ministry of War Transport on a wide scale, and has already saved many men from death by exposure to the elements.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Ascorbic Acid in Oranges

IN 1934 Bacharach, Cook and Smith[1] reported that the concentration of ascorbic acid in the peel of oranges was greater than that in the juice. This was the result of tests carried out on five bitter oranges and one sweet orange, and was afterwards confirmed by various workers[2–6]. In connexion with an investigation on methods of preparing orange juices for drinking purposes we have taken the opportunity of repeating this work. Table 1 gives the results of the examination of eight South African oranges.

TABLE 1.

	Concentration of ascorbic acid		
	mgm./gm.		gm./lb.
	Range	Average	
Whole peel	1·01–2·27	1·52	
Pulp*	0·42–0·64	0·52	
Juice	0·42–0·62	0·51	
Whole orange	0·58–1·09	0·81	0·368

* The pulp consisted largely of the skin enclosing the segments of the fruit together with a little of the inner white skin.

Two methods of preparing orange drinks have been tested: (*a*) using the juice obtained by rotary squeezing and (*b*) using a process in which thin slices of whole orange are extracted by sugar syrup. Referring the ascorbic acid content to a unit weight of one pound of oranges, Table 2 shows the results obtained.

TABLE 2.

	Ascorbic acid	
	gm.	As percent. of whole orange
Whole orange	0·368	—
Juice obtained by method (*a*) Experiment I	0·114	31·0
,, ,, ,, ,, (*a*) ,, II	0·113	30·7
Extract ,, ,, ,, (*b*) ,, I	0·238	64·7
,, ,, ,, ,, (*b*) ,, II	0·238	64·7
,, ,, ,, ,, (*b*) ,, III	0·245	66·6

If therefore it is desired to extract as much ascorbic acid as possible from oranges, method (*b*) is to be preferred, as there is made available by this means about 65 per cent of the total ascorbic acid in the whole orange as against 31 per cent obtained by using the juice alone.

The relative stability of the ascorbic acid in orange juice is generally recognized. It is therefore considered of interest to record one observation of the rapid disappearance of ascorbic acid in minced orange peel exposed to the air.

TABLE 3.

	Concentration in mgm./gm.		
	Ascorbic acid	Dehydro-ascorbic acid	Total ascorbic acid
Initial sample	2·11	0·16	2·27
Sample minced and allowed to stand for 3 hours	0·46	1·43	1·89
Sample minced and allowed to stand for 22 hours	0·14	0·05	0·19

Similar results have been obtained by us with cabbage and are recorded in the literature for cabbage and other vegetables. We are inclined to the view that this disappearance of ascorbic acid may be ascribed to the action of an oxidase.

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L. C. BAKER.

The Lyons Laboratories,
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Feb. 6.

[1] *Biochem. J.*, **28**, 1038.

[2] Levy and Fox, *South African Med. J.*, **9**, 181 (1935).

[3] Giroud, Ratsimamanga, Leblond, Chalopin and Rabinowicz, *Soc. Chim. Biol.*, **18**, 573 (1936).

[4] Hou, *Chinese J. Physiol.*, **10**, 221 (1936).

[5] Fujita and Ebihara, *Biochem. Z.*, **290**, 201 (1937).

[6] Tanaka, Yamada and Nakamura, *Trans. Soc. Path. Jap.*, **28**, 50 (1938).

Effect of Œstrin Injections on the Mouse Ovary

IN 1941 Bullough and Gibbs[1] showed that, both in the mouse (*Mus musculus* L.) and the starling (*Sturnus vulgaris* L.), maximum mitotic activity in the germinal epithelium of the ovary is confined to a short period immediately following ovulation, and it was suggested that, in all probability, some hormone, coming into full operation at this time, stimulates the epithelium to produce large numbers of new oogonia. It has since been shown[2] that a similar post-ovulation peak of mitotic activity is present in the ovary of the minnow (*Phoxinus lœvis* L.), and that in this fish it is possible to stimulate the germinal epithelium to abnormal mitotic activity, and consequently to the production of abnormal numbers of oogonia, by abdominal injections of œstrin.

Similar injection experiments have now been performed on the mouse in an attempt to produce the same effect, and after preliminary work, the following technique was devised. Twelve-hourly injections of œstrin in sesame oil were given abdominally into normal mice in early diœstrus, and the mice were killed 12 hours after the last injection. The germinal epithelium is relatively quiescent during the whole diœstrous period, which lasts on the average about three days[3]. At each injection 250 I.U. of œstrin in 0·25 c.c. of oil were introduced, and the liquid was directed into the vicinity of the ovaries. To facilitate the study of mitoses, 0·1 mgm. of colchicine in 0·25 c.c. of water was injected into each mouse 9½ hours before killing. Unusual mitotic activity of the germinal epithelium was noted after only one injection, but the maximum effect was not produced until after five injections. In the accompanying table the average number of mitoses per ovary (*a*) and the standard deviation from the mean (σ) are given.

The first group, controls receiving no œstrin, showed an average total number of only twenty-five mitoses per ovary. As none of the mice had ovulated, it must be assumed that the large numbers of mitoses obtained in the other groups were due to the effects of the injections. The ovaries of all the injected animals contained far greater numbers of mitoses than the most active of the control animals, but there was very considerable individual variation in all groups. Maximum numbers were found in the germinal epithelium of a mouse which after four injections contained 1,255 mitoses, and in another which after five injections contained 1,818 mitoses.

Average numbers of mitoses of the germinal epithelial cells in control and experimental ovaries.

Number of œstrin injections	Number of mice	Mitoses per ovary *a*	σ
0	12	25	14
1	5	122	67
4	5	664	493
5	4	747	728

It is concluded that, in the normal mouse, the bursting of the Graafian follicles at ovulation releases follicular fluid rich in female sex hormone. This comes into direct contact with the germinal epithelium, causing the observed post-ovulation peak of mitotic activity, and resulting in the replenishment of the ovary with a new stock of oogonia. Recently, other evidence has been brought forward[4] which indicates that œstrin normally causes mitosis and consequent growth in the follicles and corpora lutea, and that it induces the division of cells of the ovarian stroma. It is well known that relatively small quantities of œstrin will cause mitotic activity in the cells of the female accessory sexual organs, but it appears that the ovarian cells require far higher concentrations and are only induced to divide actively when in direct contact with highly concentrated solutions of the female sex hormone in follicular fluid.

W. S. BULLOUGH.

Department of Zoology,
University of Leeds.
Jan. 31.

[1] Bullough, W. S., and Gibbs, H. F., NATURE, 148, 439 (1941).
[2] Bullough, W. S., *J. Exp. Zool.* (in the press).
[3] Bullough, W. S., *J. Endocrin.* (in the press).
[4] Bullough, W. S., *J. Endocrin.* (in the press).

Relation of Aeration to the Activity of Proliferation-Promoting Factors from Injured Cells*

IN earlier tests of the proliferation-promoting activity of materials from injured cells ('intercellular wound hormones') in which yeast was used as the test organism[1], the test cultures were grown in rocker tubes with continuous shaking[2]. This subjected them to appreciable aeration. In recent investigations of wound hormones, yeast was again employed as the test organism, but was cultured in stationary, cotton-plugged tubes suspended in a water bath. At intervals of several hours, the tubes were removed from the water bath, shaken, and the yeast population determined with a photo-electric densitometer. In these later experiments, all preparations failed to show appreciable activity, though they had been prepared strictly in accordance with previously used techniques[1].

It was noted that the cultures containing wound hormone preparations frequently exhibited a ring of yeast growth around the inside of the tube at the air-medium interface. This suggested the possibility that the wound hormone preparations are only effective in the presence of oxygen. Furthermore, Fardon, Norris and co-workers[3], in their original investigation of the metabolic effects of products from ultra-violet irradiated yeast, found such preparations to stimulate cell respiration markedly. Hence it appeared possible that the proliferation-promoting action involved the respiratory mechanism of the cells.

To test this point, a roller tube device was constructed in which the cultures, in 3/4-in. test tubes, are attached to a wheel near its periphery and parallel to its axis of rotation. The plane of the wheel is inclined at an angle of approximately 15° from the vertical. This angle is sufficient to prevent wetting of the cotton plugs by the medium in the tubes, while the almost horizontal tube position maintains a large surface of medium exposed to the tube atmosphere. Rotation of the wheel at 54 r.p.m. provides sufficient stirring to prevent sedimentation of the organisms except in extremely dense populations and to aerate the culture to an extent presumably comparable with that obtained in the rocker tube experiments.

Growth Tests of Wound Hormone Preparations
Wet Weight of 24-Hour Yeast Crops, mgm. per ml. of culture
Concentration of materials tested:
0·1 ml. per ml. of culture.

	Stationary tubes	Roller tubes
Product from Injured Cells ...	0·16	4·05
Product from Uninjured Cells ...	0·18	0·70
Control (Reader's medium only)...	0·15	0·09

When wound hormone preparations, inactive in the stationary tube cultures, were tested in the roller tubes, they showed marked activity. A typical example is shown in the accompanying table. The preparation tested in this instance was the cell-free suspension medium obtained from yeast injured by 8-hour irradiation with full ultra-violet radiation in distilled water at a concentration of 100 mgm. wet weight of yeast per ml. Its activity is compared with that of a similar extract from non-irradiated yeast. Considerable cell death (about 6 per cent) necessarily occurred in the non-irradiated suspension due to the prolonged extraction in distilled water; hence this extract, as well as that from the irradiated cells, would be expected to show some wound hormone activity.

The necessity of aeration for growth activity of the wound hormone preparations is apparent from the table. These results have been confirmed by repeated tests in which the progress of growth at various concentration-levels of added materials has been followed at frequent intervals for periods as long as 82 hours. Full details of the experiments will appear elsewhere. Attention should be directed to the greater growth of control cultures in stationary tubes than in roller tubes. This has been observed repeatedly. The explanation is not known.

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* Contribution No. 199 from the Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.

The results strongly indicate that the wound hormone activity of products from injured cells is due to the factor or factors involved in the respiratory mechanism of the cells. The similarity of the spectra of wound hormone preparations to those of adenine nucleotide complexes[1], the indicated presence of adenine, pentose and phosphorus, and the absence of pyrimidines[5] would suggest the possibility that the active principle might be diphospho- or triphosphopyridine nucleotide. Against this possibility there are: (1) negative chemical tests for the pyridine ring[4]; (2) negative spectral indications of coenzyme I or II on reduction of the preparations with sodium hyposulphite; (3) negative biological tests for coenzyme I in our preparations. The spectral tests of oxidized and reduced preparations were undertaken in collaboration with Prof. Sizer of our department. The biological assay for coenzyme I was carried out through the kindness of Prof. Ball of the Biochemistry Department of Harvard Medical School by Mr. Jandorf of his laboratory. The possibility of the identity of the active factor with other adenyl nucleotide complexes, such as adenine pyrophosphate, yeast adenylic acid and muscle adenylic acid, is being investigated.

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Jan. 16.

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[1] Loofbourow, Dwyer and Lane, *Biochem. J.*, **34**, 432 (1940); Loofbourow, Dwyer and Cronin, *Biochem. J.*, **35**, 603 (1941).

[2] Loofbourow, Dwyer and Morgan, *Studies Inst. Divi Thomæ*, **1**, 137 (1938).

[3] Fardon, Carroll and Ruddy, *Studies Inst. Divi Thomæ*, **1**, 35 (1938); Fardon and Ruddy, *Studies Inst. Divi Thomæ*, **1**, 41 (1938); Norris and Ruddy, *Studies Inst. Divi Thomæ*, **1**, 53 (1938).

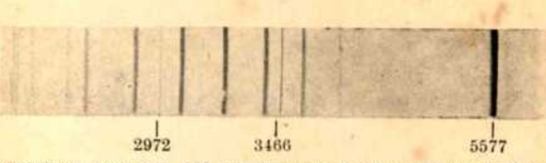
[4] Sperti, Loofbourow and Dwyer, *Studies Inst. Divi Thomæ*, **1**, 163 (1937).

[5] Loofbourow, Cook and Stimson, NATURE, **142**, 573 (1938); Cook, Loofbourow and Stimson, *Atti X° Cong. Intern. Chim.*, **5**, 26 (1939).

A Remarkable Green Line Source

IN a number of communications in these columns I have reported the observation of high relative intensities of forbidden lines of atomic nitrogen and the forbidden bands of molecular nitrogen in nitrogen afterglows. Both the absolute and relative intensities of these radiations increased with pressure over the range which had been studied up to the spring of 1941. This included pressures from about 0·001 to 30 mm. In addition, the relative intensities increased as the time between the interruption of the afterglow producing discharge and the exposure of the afterglow was increased[1]. This effect has been referred to as the temporal effect.

One of the tubes that had been used during the previous studies was cleaned and refilled with nitrogen at the high pressure of 100 mm.[2]. This tube developed a strong afterglow in a remarkedly short time, and in a few days it showed an afterglow so rich in the green auroral line that after the first half-second the afterglow was coloured green and the green line could be seen for several seconds in a vision spectroscope. The spectrum which was chosen for reproduction here shows that after the first flash of the afterglow during which the first-positive and second-positive bands of N_2 are considerably weakened, we have an almost monochromatic source of the green auroral line in the visible. The large intensity of OI $'S_0\text{-}3P$, which has about one thirtieth the transition probability of the green line OI $'S_0\text{-}'D_2$, shows in a striking manner the remarkably efficient excitation of the green line. In addition, one should note the large intensity of NI $2P\text{-}4S$.



AFTERGLOW SPECTRUM 100 MM. PRESSURE NITROGEN WITH TRACE OF OXYGEN; FIRST HALF-SECOND OF AFTERGLOW NOT PHOTOGRAPHED.

Since the discovery of this source, another similar tube at 50 mm. has been prepared, and this, too, shows equally strong forbidden oxygen and nitrogen line excitations. Therefore, the effect must be due to some change in the tube other than pressure. Other features of the afterglow show up as the small amount of oxygen disappears. Among these is the unexpectedly large intensity of the first-negative (auroral) bands of N_2^+ at both 50 mm. and 100 mm.; the large intensity of the Vegard-Kaplan bands and the large intensity of the green line when much of the oxygen has cleaned up.

These results and a proposed hypothesis to account for these tubes will be presented later, but one conclusion is already tempting, namely, that the catalytic effect of the walls of the tube for the destruction of active nitrogen has in some way been removed and the tube behaves effectively as if it had *no walls*. The large intensities of the two most striking components of the auroral spectrum, the green line and the auroral bands, lend considerable weight to this conclusion, because both ions and metastable atoms are effectively quenched at walls.

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Jan. 5.

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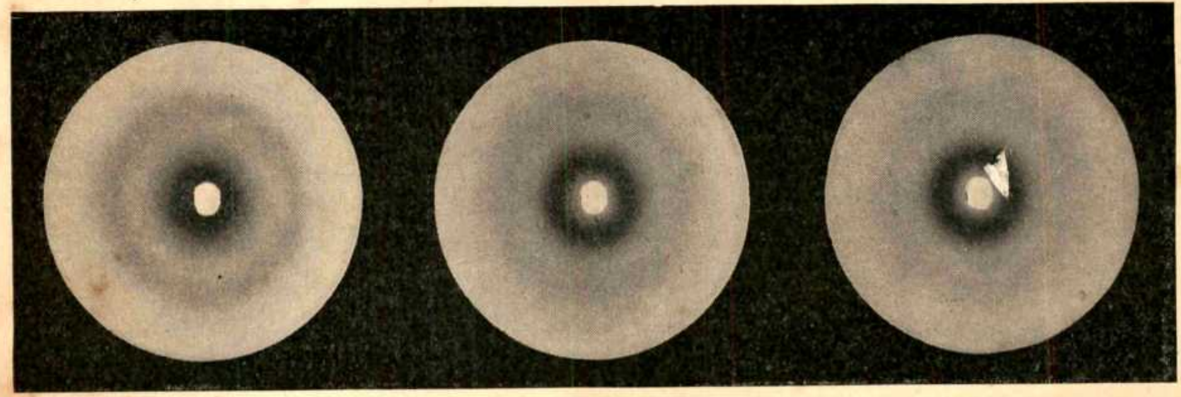
[1] Kaplan, J., *Phys. Rev.*, **57**, 662 (1940).

[2] Kaplan, J., *Phys. Rev.*, **54**, 176 (1938).

Structure of Vitreous Silica

OUR attention has recently been directed to a letter from S. S. Lu and Y. L. Chang[1] concerning the structure of vitreous silica. Two main claims are made. First, that the X-ray diffraction pattern of a thin plate of vitreous silica differs from that of the powdered material and consequently there must be some rearrangement of structure on powdering. Secondly, that the relative intensities of two strong bands in the pinhole transmission photographs of the thin plate vary according to the location of the specimen and that this indicates that large fluctuations occur in the structure of vitreous silica. Since, if true, these results would appear to suggest that the random network theory developed by Warren[2] is based upon incomplete experimental data, the experiments and conclusions described in the letter are worth critical examination.

It may be pointed out that Warren's investigation was carried out with considerable care, and precautions were taken to eliminate spurious effects. For example, the X-rays were monochromatized by crystal reflexion ; also background and small-angle scattering were reduced to a minimum by evacuating the camera. There is no precise description in Lu and Chang's letter of the experimental arrangements for taking the X-ray patterns, but it does not seem that crystal-reflected X-rays were used. It must be assumed, therefore, that the more usual method of filtration was utilized to obtain the copper $K\alpha$ radiation and that there would consequently be a white radiation component of the X-ray beam. The presence of this would provide a simple explanation of the particular form of the pinhole transmission photographs obtained by Lu and Chang. Broadly speaking, they obtained two strong bands in the transmission photographs of a thin plate of vitreous silica, thickness 0·5 mm. These bands could be derived from the same fundamental spacing in the glass structure, the outer band at 4·09 A. from diffraction of the characteristic $K\alpha$ radiation and the inner band at 8·18 A. from diffraction of the white radiation. A thickness of 0·5 mm. is too great for use with copper $K\alpha$ radiation, which would be substantially absorbed ; there would be differential absorption of the X-ray beam actually employed, the shortest wave-length part of the white radiation being much more readily transmitted than the longer wave-length characteristic radiation.



0·05 mm. 0·43 mm. 0·50 mm.

In order to test this we have obtained pinhole transmission photographs over the thickness range 0·5–0·05 mm., using filtered copper $K\alpha$ radiation. These show that the relative intensity of the inner band decreases continuously with the specimen thickness, the band effectively disappearing below about 0·1 mm. Three of these photographs corresponding to thicknesses of 0·05, 0·43 and 0·50 mm. are reproduced here. The blackening near the centre of the pattern of the 0·05 mm. specimen arises from small-angle scattering by air of long wave-length components (largely no doubt the copper $K\alpha$ wave-length) of the X-ray beam. Such blackening is much reduced on the other patterns because of substantial absorption of these wave-lengths by the thicker specimens.

By varying the tube voltage we have also confirmed that the position of the band changes with the wave-length distribution of the white radiation. These results provide strong evidence that in Lu and Chang's photographs the inner band is spurious and probably arises in the way we suggest. It is obvious that changes in the intensity of this band cannot be significant of structural variation between contiguous regions. Such intensity fluctuations might result from small changes in the experimental conditions and from any variation in thickness.

The faint but comparatively sharp lines at 3·35, 2·48 and 1·88 A. appearing in some of Lu and Chang's powder photographs correspond closely in position to three of the strongest lines in the X-ray pattern of crystalline quartz. These are just the lines which would be most likely to occur as the result of contamination of the powder with material from an agate mortar during grinding. In regard to the band at 5·80 A., it would be interesting to know what kind of medium was used for holding the powder together in the form of a cylindrical rod. Canada balsam, for example, gives a band in this position. Using the minimum quantity of cellulose binder, we have obtained a pinhole transmission photograph of a slab of powder which shows no evidence of a band in the region of 5·80 A. The photograph of the powdered material is, in fact, very similar to that of a 0·25 mm. plate.

It is therefore reasonable to conclude from these results that the bands at 8·18 and 5·80 A. obtained by Lu and Chang are spurious, and the changes they report should not, therefore, be taken as evidence of variation of structure either between neighbouring regions of a slab of vitreous silica or on powdering. Furthermore, there would seem to be no reason to suppose that the random network theory of Warren does not cover the facts.

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[1] Lu, S. S., and Chang, Y. L., NATURE, **147**, 642 (1941).

[2] Warren, B. E., *J. App. Phys.*, **8**, 645 (1937).

RESEARCH ITEMS

Incomes in Rhodesia

IN a paper reprinted from the *Transactions of the Rhodesia Scientific Association* (38, 63–73; April, 1941) J. R. H. Shaul has used the published returns of the Commissioner of Taxes in his annual report for the year ended March 31, 1938, which covers the year 1936–37, and the results of the census of population, 1936, to examine the distribution of incomes originating in Southern Rhodesia in 1936. Within certain limits, these incomes can be accurately described by Pareto's law. Formulæ are given for all incomes, for married persons and for other persons, and the available evidence suggests that the formula for all incomes changes its gradient at £350 and can therefore be utilized only in respect of incomes exceeding £350. Below £350 the following hypothetical expression for Pareto's law is deduced:

$$\log y = 5{\cdot}457 - 0{\cdot}515 \log x \; (2{\cdot}053 < \log x < 2{\cdot}544).$$

The hypothetical formula for the distribution of income in Southern Rhodesia is:

$$\log y = 9{\cdot}558 - 2{\cdot}127 \log x \; (\log x < 2{\cdot}544)$$
$$\log y = 5{\cdot}457 - 0{\cdot}515 \log x \; (2{\cdot}035 < \log x < 2{\cdot}544).$$

Petrology and Prehistory

AN important article on this subject appears in the *Proceedings of the Prehistoric Society* for 1941 under the signatures of A. Keiller, Stuart Piggott and F. S. Wallis. A large number of stones celts have been studied microscopically, a tiny portion of each tool being sliced and the outer surface of it replaced in such a way that finally it is almost impossible to detect that anything has been done to the specimen —compare the technique of the cheese-taster! The composition of the rock having been determined, it is often possible to say with fair accuracy whence came the raw material from which the tools were made. Naturally this information can help in elucidating prehistoric trade routes, or at any rate can throw light on the movements and contacts of peoples. For example, it is apparent "that while the most important area supplying the raw material for the stone axes of Wessex was Cornwall, axe-factories in North Wales and Cumberland exported their products as far south as Wiltshire at least". Such investigations, when continued further, will certainly yield very fruitful and often exciting results.

Inhibition of Growth by Chemical Compounds

MANY carcinogenic hydrocarbons retard the growth of both normal and malignant tissues and an association exists between the biological properties of carcinogenicity and growth inhibitory power. Tumour induction is conceived to take place in two stages: (1) interference with the growth of normal cells and (2) an adaptive cellular reaction, accomplished mainly by dedifferentiation, where the altered cells are able to achieve independent multiplication at an increased rate in an environment which makes normal growth difficult or impossible for their parent cell. While the new growth characters appear in response to a specific pathological change in the cellular milieu, the cellular changes themselves are permanent and continue to be manifested indefinitely and without reversion when the variant cells reach normal tissues either in the same host or artificially in other hosts by transplantation. With the prospect of discovering compounds possessing enhanced inhibitory activity, but with carcinogenicity restricted, G. M. Badger *et al.* (*Proc. Roy. Soc.*, B, 130, 255; 1942) have investigated the growth inhibitory activity of more than two hundred carcinogenic compounds and related substances. A striking degree of correspondence was often shown by the inhibitory and carcinogenic activity of closely related compounds, such as dibenzfluorenes or dibenzphenanthrenes, although no inhibitory activity was observed for certain carcinogenic 10- and 9 : 10 substituted benzanthracenes. Conversely, inhibitory activity was noted in a few compounds (1 : 2′-azonaphthalene) which have yielded few or no tumours in exhaustive tests, and in some of a group of synthetic œstrogens, which although not carcinogenic in the usual sense are nevertheless associated with the induction of individual types of tumour under special conditions. The results obtained with derivatives of triphenylethylene suggest that inhibitory activity may still be shown by compounds diverging widely from the polycyclic structure and possessing only a skeletal resemblance. In view of the similar inhibitory effects produced on body growth, tumour growth and gonadal activity by the polycyclic carcinogenic hydrocarbons and by œstrogens, carcinogenic in a restricted sense, it is likely that the mechanism in both cases is partly direct and partly moderated by the pituitary.

Streptolysin O

MANY strains of hæmolytic streptococci produce filterable hæmolysins. The hæmolytic activity of fresh broth filtrates in which hæmolytic streptococci have grown rapidly disappears on standing in air and can then be restored to the original level or higher by the addition of reducing agents such as hydrosulphite. This hæmolysin (streptolysin *O*) is produced by most strains of group *A* streptococci when grown in serum-free broth, by group *C* strains from human infections and by group *G* strains, but not by streptococci of other groups. Another serologically different hæmolysin (streptolysin *S*) is produced when hæmolytic streptococci are grown in media containing serum, and its activity is not affected by oxidation and reduction. Herbert and Todd (*Biochem. J.*, 35, 1124; 1941) have purified streptolysin *O* and have shown it to be a protein which hæmolyses red blood corpuscles only after activation with reducing agents such as compounds with -SH groups, resembling certain other enzymes, for example, papain, in this respect. A possible explanation of the hæmolytic action of streptolysin *O* is that it is an enzyme which attacks a constituent of the red cell membrane. Although no appropriate substrate has yet been found for the demonstration of its enzymic function, yet the extremely small doses in which all bacterial toxins work suggest that their action must be catalytic. It is noted that two bacterial toxins have already been identified as enzymes, namely, the α-toxin of *Cl. welchii* as a lecithinase, and the 'diffusing factor' of the same organism and of streptococci as a hyaluronidase, and the possibility exists that all bacterial toxins are enzymes.

New Silver Firs from Asia

THE activities of various botanical explorers in eastern Asia have made an immediate contribution to floral beauty in the garden, but the taxonomic and horticultural evaluation of trees is a slower process. Nurseries at Chandlers Ford and Winchester have been used to propagate the newer Asiatic silver firs from seeds collected by Forrest, Wilson, Kingdon Ward and others. Edwin L. Hillier has now described some of the species there which have grown sufficiently to provide reliable specific characters (*J. Roy. Hort. Soc.*, 66, Pts. 11 and 12, Nov. and Dec., 1941). The Chinese silver fir, *Abies Georgii*, and *A. Forrestii* promise well as ornamental trees, and sixteen other species are described in detail, mainly from the horticultural point of view. It is still too early to assess any significance the various species may have for afforestation in Great Britain, but the English material should provide useful data for a future ecological comparison with trees in the native habitat, for most of the original collections are from sites above 10,000 ft. high.

Linkage Studies

F. B. HUTT (*J. Hered.*, 32, 357; 1941) for the fowl, and W. E. Castle and P. B. Sawin (*Proc. Nat. Acad. Sci.*, 27, 519; 1941) for the rabbit, report the discovery of a fifth linkage group. Multiple-spurs are linked with duplex comb in the fowl with a cross-over percentage of 28 per cent. Multiple-spurs which are characteristic of the black Sumatra fowl are inherited as a dominant and may be easily detected in 98 per cent of young chicks. In the rabbit, furless and brachydactyly are linked with a cross-over of 28 per cent, while dwarf is now added to the agouti-wide-band linkage group.

Solar Radiation and Atmospheric Temperature

DR. H. ARCTOWSKI, a well-known Polish meteorologist who was stranded in the United States by the outbreak of war, has been investigating the effect of variations of solar radiation on atmospheric temperature, and his first results have been published (*Smithsonian Mis. Coll.*, 101, No. 5). He found that while in a few cases a direct effect on surface temperatures could be shown, these are exceptions, and he concluded that while solar variations are undoubtedly important, their effects are very complex, and probably occur mainly in the upper air. The greater part of the paper therefore consists of a study of the variations of temperature up to 17 km., mainly on the basis of *radio-sonde* ascents in the United States. Waves of rising or falling temperature, with their accompanying effects on pressure, travel in different directions at different heights, so that the combined effect at the surface is one of almost inextricable confusion, but there is a possibility that a direct effect of solar variation on temperature may occur at some level in the stratosphere. Dr. Arctowski however distinguishes *two* tropopauses, polar and equatorial, which are superposed in temperate latitudes. Very little attempt is made to relate the observed changes of temperature at any height directly to observed variations of the solar constant, and it is evident that many more data are required before there is any hope of a solution of this important problem.

Adsorption of Metals of the Iron Group in Analysis

A PAPER on the above subject was read by G. J. Austin before the Society of Public Analysts and Other Analytical Chemists on February 4. The effect of *p*H on the adsorption and solubility of aluminium hydroxide in analysis has been studied. The ammonia method of separating aluminium from nickel was shown to be impracticable owing to the great increase in the adsorption of nickel over a limited range of *p*H. Data were given comparing the extents to which adsorption takes place in the precipitation of iron, aluminium and chromium by the ammonia method, the benzoate method and the author's phosphate method. Some other methods were also referred to. It was shown that the phosphate method is better than the ammonia method in minimizing adsorption, but that in absence of phosphate the benzoate method is better than the phosphate method.

Solvent Effect and Dipole Moments

IT has been known for some time that the dipole moment of a compound measured in solution may differ from that measured in the vapour state. The reason for this difference is broadly known and the so-called solvent effect has been studied in many cases. In the measurements, both with vapour and liquid systems, the main difficulty is now the estimation of the so-called atom polarization, which cannot be determined directly. By combining the two sets of measurements, some of the uncertainty attached to atom polarization may be removed. A. Audsley and F. R. Goss (*J. Chem. Soc.*, 864; 1941) have now discussed methods for distributing the polarization of binary liquid mixtures between their components. The so-called distortion polarization, the sum of the electronic and atom polarizations, $P_E + P_A$, obtained by the elimination method just mentioned, has been distributed over the carbon, hydrogen and halogen atoms in compounds of the type RX by making use of an additive relation in which $P_E + P_A$ is the sum of contributions assigned to each atom or bond. It is shown that on ascending the series from fluorine to iodine the electron polarization P_E increases but the atom polarization P_A shows a general tendency to decrease.

High-voltage Porcelain Insulators

A PAPER read recently by J. S. Forrest before the Institution of Electrical Engineers discusses the electrical characteristics and performance in service of porcelain insulators for outdoor apparatus for voltages between 33 and 220 kv., and emphasizes the necessity for a carefully planned field-testing scheme supplemented by laboratory investigation if system breakdowns are to be minimized. The first part describes the laboratory and field-testing equipment used by the Central Electricity Board and proceeds to an outline of the technique employed. The second part gives details of investigations made with the apparatus and methods previously described, and information is provided regarding the performance of line insulators, post insulators and bushings, discussing their behaviour under adverse weather conditions. Comparative results are given for normal and anti-fog insulators, the mechanism of insulator flashover in fog being described in detail with suggestions for a good anti-fog insulator. A discussion on the deterioration of insulators in service advocates field-testing to prevent single faulty units of suspension insulators leading to a complete breakdown of the string containing them, and describes the mechanism of insulator failure due to cracking. Considerable attention is given to the cause and characteristics of radio interference due to power lines, data being given of the interfering field strength under various weather conditions.

THE SUN AND THE IONOSPHERE

THE thirty-second Kelvin Lecture of the Institution of Electrical Engineers was delivered by Prof. Sydney Chapman on May 8, 1941, and has now been published (*J. Inst. Elect. Eng.*, 88, Pt. 1, No. 11, Nov., 1941). The first part of Prof. Chapman's lecture, dealing with the origin of solar energy by the 'combustion' of hydrogen, was printed in NATURE of June 28, 1941, p. 792.

The process begins when the solar gas has reached a temperature of 20×10^6 °C. and a pressure of 10×10^9 atmospheres near the sun's centre, the 'burning' of the hydrogen nuclei thereafter maintaining the temperature and preventing further contraction for thousands of millions of years. In this reaction, the hydrogen protons are built up into helium nuclei during a six-stage reaction involving a catalyst, which at the outset is an ordinary carbon nucleus $^{12}_{6}C$. The equations of these reactions indicate a few million years for the fertilization of a carbon nucleus by four successive protons to beget one α-particle. If the birth-rate is high at the sun's centre, it is on account of the immense number of carbon atoms and protons.

This catalytic reaction is enormously productive of energy, 1 lb. of hydrogen nuclei evolving radiant energy equivalent to 100 million electrical units, compared to 4½ units for 1 lb. of coal. Energy has a mass of 1 gm. per 25 million electrical units, and hence the radiant energy from 1 lb. of hydrogen nuclei has a mass of 4 gm., by which perceptible diminution the mass of the resulting helium nuclei falls short of 1 lb. For a loss in mass of four million tons/sec. the sun has a heating and lighting output of 10^{24} kw. Radiation leaves the sun with a spectral distribution corresponding roughly to 6,000° C., consisting of highly directional electromagnetic waves, the average frequency of which is nearly a billion kc./sec. In the sun's upper layers the outward flowing radiation energizes many surface phenomena, the most evident being sunspots and prominences. Much solar gas in prominence form leaves the sun, which thus sends forth matter as well as radiation into surrounding space; and this matter, in the form of rare gas streams, assists the solar radiation in the ionization of the earth's outer atmosphere.

All but a tiny fraction of the sun's colossal energy output is lost in space, the earth's input of 170 billion kw. being but one thousand millionth of the parental output. Prior to entry into our atmosphere, this includes radiation of all wave-lengths, which may be resolved into a spectrum containing visible radiation or sunlight proper, ranging from violet to red (3900–7700 A.), and outside this the infra-red and ultra-violet. Much of the sun's light and heat pass through the atmosphere to the earth's surface, but the blue sunlight is dispersed. At an altitude of 15 miles above the atmosphere the sky is dark as at night. Energy absorbed by land and sea energizes almost all living processes, weather phenomena and geological changes, afterwards returning to space as heat radiation. Very little of the sun's radiation reaches the ground, the rest being absorbed at different levels by ozone, oxygen and nitrogen. Between 10 and 70 miles altitude, dissociated oxygen atoms combine with oxygen molecules to form ozone, an extremely rare constituent of the atmosphere, which, if collected at the earth's surface would, at the prevailing temperature, have a thickness less than $\frac{1}{8}$ in. This very small amount, spread through 30–40 miles of atmosphere, absorbs all the ultra-violet radiation (from about 2000 A. to 3000 A.), and also some of the visible and heat radiation—in all, about 5 per cent of the whole incident energy. At an altitude of 7 miles, the temperature is 220° abs. (−53° C.), rising with increasing altitude to greater than 100° C., cooling again after a further 25 miles, according to the band spectrum evidence of the Northern Lights.

The absorption of radiation in the extreme ultra-violet end of the spectrum can ionize molecular oxygen and nitrogen, which, absorbing at different levels, can provide a two-layer ionosphere. Appleton recognized the existence of two distinct main ionized layers: the lower or E layer, at 60 miles, and the upper or F layer. The latter in day-time in middle and lower latitudes consists of two parts, F_1 at 130 miles and F_2 at 200 miles. The E layer appears to remain nearly constant in height, whereas the F_2 varies greatly. Absorption of the ionizing solar radiation is more likely to be due to molecules than to atoms. Molecular nitrogen extends upwards for hundreds of miles above the ground, whereas molecular oxygen is probably scarce at 70–80 miles; hence the ionized nitrogen layer is likely to be situated above the ionized oxygen layer and we may probably identify the nitrogen layer with F, and the oxygen layer with E. Appleton and Hulbert consider that the temperature of the F_2 layer rises, due to some radiant energy being absorbed and converted into heat within the layer, causing an upward expansion and rarefaction of the layer and demanding remarkably high temperatures of the order of 1,000° abs. Such temperatures imply large random molecular velocities in the F_2 layer, weakening the earth's gravitational attraction on the air there, especially for hydrogen and helium, which probably leak away into space. Helium has constantly been reproduced radioactively from the earth's crust for more than a thousand million years, but the atmosphere does not contain the corresponding amount of helium. When the layer cools in the late afternoon it sinks, producing the abnormal second maximum of ionization.

Solar control of the ionosphere is indicated by the change in electron density following the 11-year sunspot cycle, the ionization having changed by 50–60 per cent between the sunspot minimum of 1934 and the sunspot maximum of 1937, implying a still greater increase, of 120–150 per cent, in the ultra-violet intensity. A similar change has long been revealed in the intensity of the system of electron currents flowing in the upper atmosphere, by their daily magnetic field variation, and this gave the first indication of an ionosphere, long before the advent of radio communication. The most remarkable irregular ionospheric changes are those associated with magnetic storms, causing long radio black-outs of hours or days and slowly rectifying abnormalities in the earth's magnetic field. The F_2 layer is most usually affected, except in high latitudes, where the E region may be intensified and extended downwards to cause a radio black-out resembling those due to solar eruption, except that they may occur at night and be of longer duration. Appleton and his collaborators have discovered that the earth's field imposes a spiral character on the motion of electrons in the ionosphere, making the air anisotropic for the transmission of radio waves, permitting determination of the field intensity in the region of refraction of returned waves; and that the E layer sustains lunar tidal motion twice per lunar day, the ionospheric tide having the unexpected range of about 1 mile, and producing by dynamo action a system of electric currents, detectable by their magnetic effects at the ground, apparently flowing in or below the E layer.

There also flows in the ionosphere a system of currents wholly governed by the sun, manifesting themselves by ordinary daily magnetic variations, the total current being about 200,000 amp., roughly ten times as great as those due to lunar tides. The total current intensity in the greater system is only about twice that of a single lightning flash and the current density is extremely low, contributing inappreciably to the heating of the atmosphere. In a quite moderate storm there appears to be an intense current system (more than half a million amperes) in the ionosphere over each polar cap; the magnetic effects over the remaining ·90 per cent of the earth betoken a current system of about the same total intensity.

ELECTRONICS IN INDUSTRY

IN May 1941, as a result of considerable interest in the various branches of industrial radiology, the Institute of Physics formed an Industrial Radiology Group (see NATURE, June 7, 1941, p. 706). Recently there has been a widely expressed wish among members of the Institute for the formation of a similar group for electronics. It was decided, therefore, to hold a Conference on Electronics to ascertain whether there existed sufficient interest to justify the formation of such a group. This Conference was held at the Royal Institution on January 28 under the presidency of Prof. J. D. Cockcroft. It consisted in the reading of three papers followed by a general discussion and was well attended, members from many parts of Great Britain being present, as is usual at such meetings of the Institute.

Prof. Cockcroft, opening the proceedings, spoke of the widening field of application of electronic devices, and said that it is becoming increasingly difficult for physicists to keep in touch with developments in such specialist fields. He thought that the Conference would justify itself if it helped to minimize this difficulty.

The first paper, on "The Efficient Production of Light by the Electric Discharge", was read by V. J. Francis of the General Electric Company. The author pointed out that the scientific study of the efficient conversion of energy into radiation by means of electric discharges in gases is comparatively recent. Although the efficiency obtainable is several times that possible by any other known means, in practical lamps the efficiency of conversion is still only 12–15 per cent, and a wide field for research still exists. Under certain ideal experimental conditions, efficiencies as great as 90 per cent have been recorded.

Mr. Francis then discussed the sodium and mercury vapour discharges in order to explain some of the principles involved in obtaining high luminous efficiency. The former requires low pressure and low current density because the resonance radiation is in a useful part of the visible spectrum; while with mercury, where the useful transitions are between excited states, the conditions leading to high efficiency are high pressure and high current density. He then dealt briefly with some of the applications of luminescent powders to discharge lamps. In one interesting application, practically all the light is obtained from the luminescent powder, which is excited by ultraviolet radiation produced with an efficiency of some 70 per cent in the low-pressure mercury vapour discharge. Finally, the possibilities of the mercury vapour discharge as a high-brightness source were mentioned; very high brightnesses are possible by this means.

The next paper, on "The Control Characteristics of Thyratrons and Ignitrons", was given by H. de B. Knight, of the British Thomson-Houston Company. The author first dealt with the dependence of the ratings and control characteristics of hot-cathode thyratrons on cathode emission, on the geometry of the electrodes and envelope, and on the gas or vapour density. In gas-filled valves the density is constant and control characteristics are independent of temperature; but the working voltage is limited to about 500 volts. For high power, mercury vapour is used; but the vapour pressure must be controlled, especially for heavy current densities and high voltages (above 15 kv.) Mr. Knight showed many interesting curves illustrating these characteristics. Ionization time comprises a delay period in which practically no current passes, followed by a shorter 'build-up' period in which the plasma becomes established. Both periods are relatively independent of vapour pressure, but are affected by the grid voltage and resistance, and especially by the shapes of the electrodes and the field distribution in the arc space. De-ionization time is a function not only of valve design but also of the circuit.

In dealing with mercury pool rectifiers, controlled by cathode spot formation, the author said that the 'Ignitron' alone finds wide industrial application. The delay time between the igniter current and the main arc depends on the rate of rise of igniter current. A delay of less than one microsecond can be obtained; but up to 50 microseconds or more is satisfactory for most industrial uses.

A. J. Maddock, of Standard Telephones and Cables, read the third paper, on "Hot-cathode Gas-filled Triodes (Thyratrons) and their Applications in Research and Industry". The author described the various ways in which these devices may be used. An outline of the principles of the several basic circuits that can be employed in most applications was given, and these were illustrated by interesting demonstrations so that the properties of the various circuits and the effects resulting from the use thereof were readily apparent.

The circuits discussed included those for use on A.C. and D.C. supplies, and showed the range of control obtainable in the former case as the point at which the grid loses control in each positive half-cycle of the alternating anode voltage is varied; and in the latter case how a second thyratron or switch may be used to stop the flow of current through a thyratron already passing current by applying a negative impulse to the anode of the first thyratron. Extension of this leads to the inverter circuit which produces an A.C. output from a D.C. input.

Several grid circuits were illustrated suitable for use in covering such applications and control as timing, impulse, variable reactance, variable resistance (including use of photo-electric cells), variable phase, etc. Examples of the use of these devices ranged from circuits for high-speed counting of physical phenomena and the generation of current pulses of accurate time duration used in research to large industrial plants such as high-tension rectifiers developing 600 kw. at 14,500 volts, large variable-speed motors operating on an A.C. supply, and inverters with the possibility of transmission at high D.C. voltages, together with the realization of a virtual static D.C. 'transformer'.

A lively discussion ensued which ranged over a number of topics, and in particular many questions were asked concerning the behaviour and application of the gas-filled triodes. It was clear, as Prof. Cockcroft said in closing the discussion, that there was sufficient interest for the Conference to go on indefinitely, and the Conference passed a resolution requesting the Board of the Institute of Physics to sanction the formation of an Electronics Group.

UTILIZATION OF INDIAN HOME-GROWN TIMBERS

A FOREST Bulletin, No. 92, Utilization (New Series), has been written by V. D. Limaya of the Forest Research Institute, Dehra Dun, on "The Testing of Packing Cases for Army Boots and suggested Improvements." (Govt. of India Press, New Delhi, 1941). Packing cases for army boots in India have usually been made of chir (*Pinus longifolia*) in the past. Owing to the large demand brought about by the War, other timbers for the purpose have come under review. The Ordnance Department suggested that semul (*Bombax malabaricum*) might answer equally well and would be more easily available as the species is not more or less confined to the outer hills of the Himalayan range. Since, however, it is a softish wood, doubts were expressed as to its suitability. Comparative tests of both timbers were therefore undertaken in the Timber Testing Section of the Institute. These tests showed that semul boxes were practically as strong as chir boxes and possessed in addition certain advantages. But the tests went further, and indicate how war-time emergencies sharpen the faculties. It was discovered that the original design could be greatly improved so as to produce a far stronger box by very small additions costing not more than two annas a box. Boxes so made were tested and found to be fifteen times stronger than those made according to the original design. The advantages to an army at war will be readily understandable. Two plates show the old box and its failure to stand certain stresses and the new one.

Bulletin No. 93, by the same author, is entitled "Indian Timbers for Tool Helves and Handles". When there has been a Forest Department in India for nearly eighty years and a Research Institute for well over thirty, it is difficult to account for the fact that up to quite recently very large quantities of hickory and ash handles were imported from America into India annually. In fact the big American manufacturers were doubtless correct in saying that "We 'handle' the World". Hickory only grows in the lower Mississippi valley and yet hickory tool handles and helves are to be found in use in practically every country in the world. Ash is also used to a very large extent for the lighter types of handles. These two species have very nearly monopolized the tool handle trade of the world. Until comparatively recently this remained true for India in spite of the large number of species growing in the great Indian forests.

The work carried out at the Forest Research Institute has, however, resulted in greater interest being taken in Indian timbers in this respect, with the result that more than three quarters of the railway demand for tool handles (the largest demand in the country) is now met by handles made in India from Indian woods.

The author states that "wooden handles for tools are really becoming a world problem". Manufacturing processes require the use of various types of cutting tools and hammers and the demand for wooden handles for such tools has increased enormously. While admitting that hickory is rather a special type of timber and that it will probably remain in demand for special uses, it is now proved that certain Indian timbers fulfil the requirements for tool handles. The research work of the Timber Testing Department had resulted in the markets being supplied with tool handles made from Indian timbers, and the War has given a great impetus to the tool handle trade, large orders having been placed for pick-axe helves, hammer handles, axe-helves, wooden mallets, handles for entrenching tools, spades and so forth.

Some of the species of timbers used belong to about twenty genera. These, according to their qualities, are used for heavy hammer handles (hickory class), light hammer handles (ash class), axe helves (hickory class), handles for scooping tools (ash class) and handles for cutting tools (beech class). Other woods of small forest species are being tested. For example, *Anogeissus pendula*, which until recently was practically unknown as a tool handle wood, has been found to be the toughest timber ever tested.

DOWNWARD RADIATION OF THE EARTH'S ATMOSPHERE

IN Scientific Notes of the India Meteorological Department (8, No. 93) R. Narayanaswami gives a comparison between measurements of the downward radiation of the earth's atmosphere at night made by himself at Bombay between March 1937 and October 1938 and similar observations by Ramanathan and Desai at Poona in 1930–31. The interest of the comparison lies in the fact that the climates of the two places are in strong contrast, Bombay having a coastal climate of exceptional dampness, while at Poona the climate is continental apart from the rainy season (June–September), and at times very dry, the annual rainfalls being about 70 in. and 27 in. respectively.

The instrument used both at Bombay and at Poona for measuring the atmospheric radiation was Angstrom's pyrgeometer No. 48, made by G. Rose of Upsala. With this was measured the net radiation per horizontal square centimetre, that is, the difference between the full emitted black body radiation given by σT^4 and the radiation received from the atmosphere, interest attaching mainly to the comparison between the ratio sky radiation to full radiation, and the vapour pressure of the air around the instrument calculated from the readings of an Assmann psychrometer. Since the radiation from the sky is practically all due to the water vapour in the atmosphere, dry air being an exceedingly bad radiator, in so far as there is considerable positive correlation between the water vapour pressure near the ground and in the overlying atmosphere as a whole, so the ratio $S/\sigma T^4$, where S is the sky radiation, and the vapour pressure near the ground, show high positive correlation. Comparison between these quantities and the dry-bulb reading of the Assmann psychrometer is made by tables and graphs.

Throughout the year, except possibly in October, the excess of S at Bombay compared with Poona is almost as marked as is the excess there of vapour pressure. An interesting point confirming that it is mainly the annual variation of vapour pressure that causes the annual variation of S and not the annual variation of temperature is to be noted at the onset of the monsoon in June. Temperature falls but vapour pressure and cloudiness increase in the monsoon current, with the result that S continues high. The lowest observed value of S at Bombay was 0·41 gm.cal./cm.^{2} and the highest 0·66 gm.cal./cm.^{2}. At both places the maximum for S is in the monsoon and the minimum in the winter.

FORECASTING MONSOON RAINFALL

IN Scientific Notes of the India Meteorological Department (8, No. 95) V. Doraiswamy Iyer and C. Seshachar have usefully extended some work done by Sir Gilbert Walker in 1921 on the forecasting of the monsoon rainfall of Mysore State as a whole from the three factors: mean atmospheric pressure over India in the preceding May, Zanzibar rainfall in the same month, and Java rainfall for the period October–February. The multiple correlation coefficient obtained in this way was + 0·57.

It is shown by means of a map of normal monsoon rainfall (June–September) that Mysore includes two regions of widely different rainfall, the *Malnad*, which is a narrow strip of country adjoining the Western Ghats, with a monsoon fall varying from 30 in. to more than 300 in., and the *Maidan*, or plain country, which lies farther to the east and includes most of the State, with a fall of less than 30 in. Monthly normals show that in the *Malnad* July is much the wettest month, followed by June and August, whereas the rainfall of the *Maidan* is greatest from May to October with a much less pronounced maximum spread over September and October. It is known, further, that a strong monsoon circulation favours the rainfall of the *Malnad*, whereas a weak monsoon is more productive of the heavy convectional showers that give the *Maidan* a large part of its rainfall. The expectation that higher correlation coefficients might be expected for each of these regions considered by itself, when the factors used are those most suitable to each rainfall regime, than the one found by Walker for the whole State was fulfilled.

Using a number of new factors, which included sunspot numbers, multiple correlation coefficients of 0·60 and 0·70 were found for the *Malnad* and *Maidan* regions respectively. The work was extended in the case of the *Maidan* to the period September–November so as to include the two wettest months for that region, and for forecasting the rainfall of this period a multiple correlation coefficient of 0·75 was found. The factors used in this case were the *Malnad* rainfall for the previous June–August, Bangalore mean winds at 2–3 km. height in July and August and mean India pressure gradient in July and August. The effectiveness of each of the three formulæ is roughly illustrated by graphs of calculated and observed rainfall over a long period of years. These suggest that the forecasts would be of value to engineers concerned with water supply and to agriculturists, in spite of occasional failures due to the fact that the basic correlation coefficients fell very far short of unity.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Saturday, March 7

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. P. D. Stebbing: "A Review of References to Geology and Allied Subjects from the 16th Century" (Presidential Address).

Monday, March 9

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Capt. D. L. Leach: "The Survey of Sarawak".

Tuesday, March 10

Chemical Engineering Group (Society of Chemical Industry) (joint meeting with the Institution of Chemical Engineers) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. N. Fleming: "Noise and its Suppression".

Illuminating Engineering Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Discussion on "Advance Planning in Lighting Reconstruction", to be opened by Mr. Howard Robertson.

Royal Institution (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Metals", 2: "Metal Geography".*

Friday, March 13

Royal Society of Arts (India and Burma Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Colonel Sir Arthur Olver: "Animal Husbandry in India".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (woman) in Mathematics—The Secretary, Somerville College, Oxford (March 10).

Educational Psychologist—The Secretary for Education, Education Offices, York (March 12).

Deputy Borough Electrical Engineer—The Town Clerk, Town Hall, Sunderland (endorsed 'Appointment of Deputy Borough Electrical Engineer') (March 14).

Engineering Assistant—The Chairman, Mid-Kent Water Company, Snodland, Kent (March 15).

Organizer of Agricultural Education for the Administrative County of Kesteven—The Clerk to the County Council, County Offices, Sleaford, Lincs. (March 16).

Lecturer in Anatomy—The Secretary and Registrar, University, Bristol (March 16).

Scientific Assistant (woman not liable for National Service)—The Deputy Director, Imperial Bureau of Pastures and Forage Crops, Agricultural Research Building, Penglais, Aberystwyth (March 21).

Teacher with high qualifications in Biology—The Headmaster, The School, Dartington Hall, Totnes.

Biochemist (man or woman) in the Pathological Laboratory—The General Superintendent and Secretary, Salford Royal Hospital, Salford, Lancs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Advancement of Science: the Report of the British Association for the Advancement of Science. Science and World Order: Transactions of a Conference of the Division for the Social and International Relations of Science. Pp. 120+vi. ((London: British Association.) 5*s*. [102

The Future of Auditing. By a Group of Accountants in Industry. (A Series of Four Articles reprinted from *The Accountant*). Pp. 28. (Potters Bar: Gee and Co. (Publishers). Ltd.; London: The City Library.) [102

Medical Research Council: Industrial Health Research Board. Emergency Report No. 2: Hours of Work, Lost Time and Labour Wastage. Pp. iv+26. (London: H.M. Stationery Office.) 6*d*. net. [112

Other Countries

Rubber Research Institute of Malaya. Abridged Annual Report. 1940. Pp. 19. (Kuala Lumpur: Rubber Research Institute of Malaya.) [92

U.S. Department of Agriculture. Technical Bulletin No. 784: The Wheat Jointworm in Oregon, with Special Reference to its Dispersion, Injury and Parasitization. By T. R. Chamberlin. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents. [92

Records of the Geological Survey of India. Vol. 75, Professional Paper No. 11: A Study of Certain Indian Coals. By E. R. Gee. Pp. iii+46+v. (Calcutta: Geological Survey of India.) 2 rupees; 3*s*. [112

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PRODUCTION AND HOURS OF WORK

IN 1915 the Health of Munition Workers' Committee was appointed "to consider and advise on questions of industrial fatigue, hours of labour and other matters affecting the personal health and efficiency of workers in munition factories and workshops", and in 1918 the final report was published.

By means of *ad hoc* investigations and verbal evidence the Committee came to the conclusion that the long hours worked were detrimental to the health and efficiency of the workers, although they did not feel that they could definitely fix a limit for a suitable working week. Since 1918, much research work has been done and definite knowledge is now available that was lacking in 1918. For many reasons there has been a growing recognition of the importance of a reasonable working week. Before the present War some prominent firms had adopted the five-day week, and the necessity for adequate holidays and other aspects of industrial welfare had received much attention.

For research purposes the problem of hours had receded into the background, and investigations into less obvious environmental conditions, the effects of boredom, accident proneness, vocational guidance and selection, as well as problems of mental and physical health were conducted and published.

Apparently the lessons of the War of 1914–18 were not appreciated by the country in general, and so it has been necessary for the Industrial Health Research Board to publish a report* which has for its aim the consideration of some of the hindrances to maximum production in relation to the human effort.

The idea of man as a machine dies hard. For maximal industrial production there must be a regular flow of materials, the machines must be in perfect working order, and the worker of the machine must be in good health. For good health he needs, at least, adequate food, regular sleep, regular periods of leisure and reasonable conditions of work. Since the human being is not a machine he has the power to "rise above himself", to make himself by force of will produce more work than is his ordinary maximum. Hence the amazing success of emergency efforts. Unfortunately, those in authority often fail to acknowledge, except by lip service, the extraordinary as being extraordinary, and complain when the extraordinary gives way, as it must, to the ordinary. If a war were of a few weeks' duration, then little harm would be done by continued long hours, but when in this, as in the last, it is a question of years, then a steady output that can be regularly maintained is better than overwork followed by a steady decline.

This report shows the extraordinary efforts made by workers after Dunkirk. Throughout Great Britain, workers were stimulated by the state of emergency to make good the material losses incurred as a result of the collapse of France, and the effort was reflected in the production. The strength of the incentive, however, gradually waned, and fatigue and boredom could not be ignored. The time lost due to sickness, injury and absence without permission, when undisturbed by extraneous factors, varied with the weekly hours of work. It was usually reasonably low when the hours of work were less than 60 per week, but was higher and in some cases excessive when the hours were 65–75 per week. Unexplained absence of short duration rose with the increase of hours; this type of absence was due often to the desire for rest, or for a change from the monotonous conditions of the work. In almost every case holidays were followed by an increase in the rate of working. Labour wastage was high in some factories and particularly where large numbers of women unaccustomed to factory work were employed; domestic responsibilities, the difficulties of shopping and the problems of transport played a large part in this loss.

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* Medical Research Council: Industrial Health Research Board. Emergency Report No. 2. Hours of Work, Lost Time and Labour Wastage. Pp. iv+26. (London: H.M. Stationery Office, 1942.) 6*d*. net.

The findings resulting from the investigation suggest that over an extended period the weekly hours of work should generally not exceed 60–65 for men, and 55–60 for women. The report concludes with these words: "When it is remembered that many workers lived far from the factories, and had to face air-raids when travelling to and from work; that some had lost their homes and had to sleep in improvised shelters; and that often they had to wait outside in the cold and rain because of inadequate transport arrangements, the time-keeping of the factory personnel studied deserves high praise."

That the Government recognizes the importance of such investigations as those of the Industrial Health Research Board is already apparent from the announcement, recently issued, recommending that the customary annual holiday, with a break of one day on Easter Monday, Whit-Monday and August Bank Holiday and of two days at Christmas or the New Year, should be taken. By this means it is hoped to maintain the health of the workers and also to keep up production. Nevertheless, a scientific study of the many human problems of labour is as necessary now as in the War of 1914–18, and will be still more necessary after the War.

GEOLOGISTS IN WAR-TIME

THE support given by a modern State to geological studies usually takes the form of a Geological Survey, the functions of which are, broadly speaking, twofold: namely, to prepare and publish geological maps and generally to promote the study of geology, and to collect and record geological information of economic importance relative to mineral resources and water supply. The balance between the two aspects must be delicately held, and depends to a large extent on circumstances; thus in time of war, economic work will hold first place.

Great Britain is served by an excellent Geological Survey, which has been in existence for just over a hundred years. Its headquarters are at the new Museum of Practical Geology, South Kensington, and there are branch offices in Manchester, Newcastle-on-Tyne and Edinburgh. The staff consists of a relatively small band of highly trained geologists, whose activities take them to all parts of the country, either on routine work or to undertake special inquiries. Contact is maintained with geologists in universities and similar institutions, and with mining engineers and others specially interested. During its long existence the Survey has collected a vast amount of detailed information, much of which is unpublished, but is freely available for consultation at headquarters or in the branch offices. It might be thought that the very existence of such a centralized staff of trained workers would be sufficiently well known to ensure that full use would be made of their services in the present grave times, yet there is evidence that geological knowledge is not being utilized as it should be.

Prof. H. H. Read described the position very ably in an article in NATURE of January 10, p. 39. There he showed the high importance of geological studies for industry and for agriculture in locating new and substitute sources of mineral products. It may be pointed out that such sources are not only of importance in replacing supplies cut off by the spread of war, but also that whenever home supplies can be used to replace material formerly imported, there is a saving in vitally important shipping space. Geologists are also in a position to advise in connexion with the siting of camps, factories and underground storage and shelters, and we understand that a certain amount of consultation is somewhat belatedly taking place. Here perhaps the local geologist is also likely to have valuable knowledge. Nevertheless, there is no question that, in many cases geologists have not been consulted, with resulting waste of money and effort. Prof. Read also refers in his article to the remarkable results obtained during the past twenty years in the U.S.S.R. through the employment of thousands of geologists in mineral prospecting and development.

Turning now to the direct use of geology in the Armed Forces, it is of interest to note the position in the last war as described in "The Work of the Royal Engineers in the European War of 1914–1919. Geological Work on the Western Front" (Chatham: Secretary, Institution of Royal Engineers, 1922). In 1914, the Army had no geological establishment. Very soon, however, the need for expert advice in regard to water supply became apparent, and one geologist was appointed early in 1915. In May 1916, the Australian Mining Corps arrived in France, accompanied by the late Prof. (afterwards Sir) Edgeworth David, of the University of Sydney, who eventually became geological adviser on matters connected with military mining at G.H.Q. In 1916, Lieut. Loftus Hill, assistant government geologist of Tasmania, was placed in charge of special boring operations. Shortly before the Armistice was signed, further additions were made to the geological staff at G.H.Q., which eventually totalled five, in order to cope with the demand made by the advancing forces for geological maps. In September 1918, a proposal to form a definite Geological Establishment for the British Army was put forward but was too late to materialize. Throughout the War, constant touch was maintained with Geological Survey in Great Britain. Perusal of the book referred to leaves no doubt as to the multifarious uses of geological science during military operations, yet at the recent Conference on Science and the War Effort arranged by the Association of Scientific Workers (see NATURE, January 31, p. 130), it was stated that only two geologists are employed as such in the British Army.

According to the same book, the German conception of geological aid was different. Each 'army' appears to have had a definite military geological staff. In each 'corps' there were two professional geologists, with a draughtsman, clerk and boring party, attached to a field survey company, while a somewhat similar establishment, including, however, civilian research geologists, was attached to a survey company (*Landaufnahme*) apparently at army headquarters. The value of geological information was recognized in the American Armies. In 1917, Lieut.-Colonel A. H. Brookes, for many years director of the Geological Survey of Alaska, was made geologist, and a little later an assistant geologist was appointed. Finally, it was decided to increase the number of geologists with the American forces to seventeen, most of whom had been appointed before the Armistice was signed.

A certain amount of blame for the public neglect of geology lies at the door of geologists themselves. They have tended to keep their studies too much to themselves, though perhaps the very nature of their field work has separated them from other men of science. A larger portion of blame is attached, as Prof. P. G. H. Boswell showed in his presidential address last year to the Geological Society (see NATURE, April 19, 1941, p. 459), to the educational system of Great Britain, which during the past few decades has put a premium on the study of the physical sciences and thrust geology into the background. As a result, our administrators have little or no idea of the services geologists can render, and the general public has not the background of knowledge to enable it to appreciate the deficiency.

Prof. Read suggests, in the article referred to above, that the best use that can be made of the geologist at the present time is to let him carry on his geological work. To this we would add that steps should be taken to see that, whether he works as a civilian or is absorbed into the Armed Forces, his knowledge is exploited to the full in furthering the war effort. The Geological Survey does yeoman service in answering the numerous inquiries, many of which must involve lengthy and laborious investigations, sent to it by Government departments and others, and is producing a special series of War-time Pamphlets on mineral resources and water supply, but this is not sufficient. There must be more enlightened direction from above, to ensure that wherever geology impinges on human activity, in war or in peace, the contribution it can make is recognized without delay and appropriate action taken.

'UNCLE JOHN' BRASHEAR

John Alfred Brashear, Scientist and Humanitarian, 1840–1920

By Harriet A. Gaul and Ruby Eiseman. Pp. viii+220. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1940.) 14*s*. net.

IT is appropriate that the third volume in the series entitled "Pennsylvania Lives" should be devoted to John Alfred Brashear, a poor millwright with little education, who not only became famous the world over for his genius in the construction of fine precision instruments but also, through his untiring labours on behalf of the people of his native Pittsburg, became known to them affectionately as "Uncle John" and was voted "the most distinguished citizen of Pennsylvania".

Brashear acquired at an early age from his grandfather, Nathaniel Smith, a driving passion for astronomy. It was this passion that decided him to make a telescope so that others, and particularly children, should be able to see the stars, and to see them without charge. Working alone and with no one to advise or guide him, he undertook the construction of a 5½-in. refractor. He devised methods for cutting the glass into circular form and for shaping and polishing it, designing and constructing the necessary tools and plant. With no knowledge of optics he somehow, by intuitive skill, computed the requisite curves. After two years of labour in such spare time as his long hours at the mill afforded him, and with the able assistance of his clever and courageous wife, the objective was well on the way to completion when by an unfortunate accident the crown lens was broken. Nothing daunted, another disk was obtained and eventually Brashear's telescope was completed in the year 1875.

At this time S. P. Langley was director of the Allegheny Observatory, and Brashear, critical enough to be dissatisfied with what he had achieved, ventured with some trepidation to write to Langley for an interview and to submit to him his lens for criticism. Langley's advice to Brashear was to try a reflecting telescope with a silvered glass mirror, which would not require expensive optical glass and would involve the figuring of one surface only. Thus began an association which later ripened into the closest friendship and collaboration, in the course of which Brashear assisted Langley in the invention of the bolometer; successfully made for him prisms of rock-salt, after many others had tried and given up in despair; and helped him in his pioneer investigations in aeronautics.

Acting on Langley's advice, a 12-in. mirror was completed, only to split in half in an attempt at silvering by a process, taken from the *English Mechanic*, that required heat. A second mirror was completed; silvering by various methods which were tried proved uncertain and unreliable. At length, after much experimenting, Brashear devised the process that bears his name, which he published after he had tried it long enough to be sure it was infallible. With the 12-in. telescope, he devoted much of his leisure time to spreading his enthusiasm for astronomy among his fellow-workers at the mill and the children of the neighbourhood, by showing them the stars. Articles in the local papers helped to make him known in Pittsburg. To assist amateurs who desired to make their own telescopes he began in a modest way to make mirrors and eye-pieces. The work soon grew too much for a spare-time occupation, and at length Brashear resigned his position at the mill and devoted his whole time to the business of making instruments.

Through Langley, Brashear met William Thaw, the millionaire banker, to whom Pittsburg owed many benefactions and who had endowed the Allegheny Observatory. Brashear's enthusiasm kindled the interest of Thaw, who provided him with a larger shop and new equipment. Orders successfully completed for Langley, Michelson and Rowland enhanced his reputation for high-quality workmanship and his position as the principal maker of precision optical apparatus in the United States became established. Before long, the fruitful collaboration with the Warner and Swasey Company in Cleveland, Ohio, commenced; Brashear made the mirrors, lenses and spectroscopes for the large telescopes and mountings constructed by Warner and Swasey. Orders flowed in not merely from America but also from all over the world.

Science owes much to Brashear for the discoveries that the excellence of his instruments made possible; but what he accomplished in this way was only one side of his achievement. He was greatly interested in education and all cultural matters, and in the welfare of his fellow-citizens. Endowed with a vivid personality and tremendous enthusiasm, he became the intimate friend of the Pittsburgh millionaires, Thaw, Carnegie, Schwab, Frick and Phipps. Through his influence on them he was instrumental in the expansion of the Allegheny Observatory, the University of Pittsburgh, the founding of the Carnegie Institute and the Carnegie Technical Schools and the creation of the Frick Educational Commission. He became acting director of the Allegheny Observatory, when Keeler left to become director of the Lick Observatory, and raised large funds for a new observatory; the dedication in 1912 of this new observatory equipped with a 30-in. refractor and a lecture hall, open without charge to the public, realized one of the dreams of his youth. For some years he served as president of the Western University of Pennsylvania. The demands on his time for service on various boards were very heavy, but his life was essentially one of service to the community. One of his sayings was, "There is no room for the mean man in science". A great celebration was arranged for his seventy-fifth birthday, as a tribute to the high esteem in which he was held. A sonnet was written specially for this occasion by G. M. P. Baird, from which the following lines, which well describe Brashear's character, may be quoted:

Heart of a little child, thought of a mage renowned,
Simple of life and aim, humble in victory, crowned
By loves that his heart made warm and truth that
his soul divined.

This life of Brashear is sympathetically written and gives an attractive picture of a great personality. Unfortunately, the book contains many loose or erroneous statements and many minor errors. Space permits only a few to be mentioned. The description of the Foucault test on p. 55 is unintelligible; the statement on p. 78 that "what could be known of the position of the stellar bodies, their movements and distances from the Earth, had been largely solved by the first telescopes made in America", is grossly misleading. It is not correct (p. 180) that W. W. Campbell discovered the drift of the solar system through space; this was discovered by William Herschel. The statement (p. 183) that without Brashear's help few would have known how to use what he was capable of making is surely an exaggeration. On p. 194 Brashear is reported to have said, "If you would ride from the Earth to Alpha Centauri on a train, going at the rate of a mile a minute, it would take forty-eight years. We have an exaggerated sense of our own importance." This would place Alpha Centauri at about one quarter of the sun's distance from the earth. On p. 145 reference is made to a 60-in. object glass, in process of being made for the Lick Observatory: no object glass of this size has ever been attempted. There is peculiar confusion about the Astronomers Royal and the Royal Observatory, Greenwich; on p. 110 we are told that Sir James Dewar showed Brashear round the Royal Observatory; on p. 113 reference is made to "Sir William Huggins of the Royal Observatory in England"; on p. 183 Sir William Thomson is stated to be Astronomer Royal of England, while in Chapter 14, entitled "Steel Kings and Astronomers Royal", the only British men of science mentioned are Sir William Huggins, and Dr. John Tyndall, "one of the astronomers of the Royal Institute". On p. 117, when visiting Phipps at Knebworth, the Brashears were met "at the little station of Wellwyn, between London and Sheffield". Jannsen is spelt Jannsan and Galitzin is spelt Gallitzin. But perhaps the most glaring error to occur in a book about an astronomer is on p. 70; Brashear was one evening taking to Langley a mirror that he had silvered: "As he turned up the Observatory hill he looked over his left shoulder to the white crescent of the new moon rising above the city behind him. 'That's lucky', he said." A laconic comment for such a unique celestial event!

H. SPENCER JONES.

SHEARWATER LORE

Shearwaters

By R. M. Lockley. Pp. xii+238+20 plates. (London: J. M. Dent and Sons, Ltd., 1942.) 15*s*. net.

I THINK that this is the best of the many good books R. M. Lockley has written. So good is it, so full of careful observations set down in delightful prose, that I have limited my reading of the book to a chapter a night, for in each chapter there is much food for thought.

This book describes the habits of shearwaters on the author's own island of Skokholm, but in the summer of 1939 he and his wife travelled (like their shearwaters) far to the south, and he gives vivid descriptions of that visit—made just before the War broke out—to the Berlengas Islands, the Desertas and the Salvages. On the Salvages the travellers found colonies of frigate petrels nesting, small white-breasted blue petrels with long legs. That most delicate, fragile bird in flight resembled a huge mayfly. It flew above a sun-baked isle, on which the white surf thunders from the north wind that almost always blows here. The Salvages lie some 200 miles south-east of Madeira, and on the Great Salvage the nesting burrows on the crown of the island (p. 223) are occupied the year through by a succession of nesting birds. The holes are used from April until July by frigate petrels; from August until November by Madeiran petrels; and from December until March by the little shearwater. The author makes the lonely Great Salvage materialize in the reader's mind. How fortunate he was to have worked (and slept) among its delightful birds.

But I am lingering too long on these southern isles. The book is mainly about the shearwaters of Skokholm, and the author, ably helped by his tireless and enthusiastic wife, has done valuable work in testing the homing powers of these swift-winged birds of ocean and their incubation and fledging periods. He discovered that the parents (p. 32) habitually take incubation shifts of three to five days, and (p.35) that the incubation period is 52 days, or almost seven and a half weeks. By careful observations (p. 53) he ascertained that the fledging period of the young bird is 73 days and that, like the young of the storm petrel, it is deserted by its parents some days before it makes its way, unaided, from its burrow to the sea. On occasion a shearwater would continue to brood its egg, without food or relief, for a much longer period than five days. One of the birds nesting beside the author's house on Skokholm, which he named Adam, once brooded the single white egg for ten long days and nights in the burrow without being relieved by his mate. But when she took over, Aida (the mate) gave him a good spell of freedom, for she in her turn brooded for seven days without relief. Adam then brooded the egg a further nine days, losing in that time 2 oz. in weight.

From ringing experiments the author gradually realized the astonishing fact (p. 126) that the shearwaters of Skokholm actually fly to the Bay of Biscay to feed during their days off duty. That double flight in a straight line is 1,200 miles, but is well within the power of so strong a flier as a shearwater. This interesting discovery puts me in mind that I have often seen shearwaters on summer days moving south through the Sound of Mull. These, I take it, are birds which are nesting on Eigg, and it is not beyond the bounds of possibility that they too have their feeding-grounds in the Bay of Biscay.

It is no wonder that the young shearwater grows slowly, for the author has proved by experiment that on moonlight nights (it is never fed by day) the parents do not visit it. In very fine clear weather it may therefore go hungry for the best part of a week.

The recovery of various birds in Bay of Biscay waters at a time when they were actually nesting on Skokholm makes interesting reading. One of the most remarkable records (p. 124) was the discovery of a ring in the stomach of an angler fish weighing 40 lb.

The homing experiments were begun on a small scale. A shearwater from Skokholm was released at Start Point at 2 p.m. one summer day. At 11.45 p.m. the same night the bird was brooding its egg on Skokholm—and the egg was warm. That flight was a distance in a straight line of 225 miles. In Chapter 14 the author describes how he later took with him two shearwaters from Skokholm and released one 100 miles south of the Faroe Islands, the other just off those islands. When he returned to Skokholm he found both birds in their burrows, roughly 700 miles to the south. But the most remarkable homing feat was accomplished (p. 178) by a shearwater which was liberated on the shore at Venice (it had been sent by air) and returned to Skokholm, a distance of 3,700 miles by sea, in 14 days. The author seems to think it more likely that this shearwater returned overland for a part of the distance, but my own belief is that it must have kept to the sea throughout. To the shearwater, as to the gannet, the ocean is its home, and to travel over hill and plain, far from any feeding-ground, would be, I submit, foreign to its nature. I feel confident that the bird travelled by sea throughout. That is a remarkable flight: 500 miles south-east down the Adriatic, then south-west to the Straits of Messina, thence west to Gibraltar and north to Skokholm.

Since the shearwater's home is the sea, I think, therefore, it is not surprising that the majority of the birds released on the Alps (pp. 183, 184) in the summer of 1939 failed to make their way back to Skokholm. That the shearwater is a good flier even from the first is proved by the feat of a nestling which, ringed on Skokholm on September 3 before it had tried its wings, was discovered (p. 138) three days later on the coast of France.

On p. 49 there is an interesting account of how shearwaters at night climb a rock in order to 'take off' into the wind, "using legs, wings, and hooked bill, all three, to get to the top". Many birds, using the rock in this way for many generations, have worn a grove in the soft sandstone.

This book is a rare combination: exact scientific record combined with enthralling narrative written in simple, vivid English. Here is (p. 142) a literary gem:

"It had been a brilliant day with a strong north-west breeze against which a migration of swallows struggled northwards across the island, their white breasts skimming low over the yellow primroses, the white sea-campion, the first bluebells, and some early sea-pinks. A peregrine falcon, which for days had been attacking the small birds and the puffins, rose upon the wind vertically, and climbing higher and higher, dwindled and vanished against the infinite blue of the sun-filled sky. Towards evening heavy rain clouds came up out of the west and covered the setting of the young bow of the new moon. The wind eased and the whole sky became suddenly dark. That night was black and starless, and full of shearwaters."

I like, too, his description (p. 6) of the calling of oyster-catchers as a "whickering". That exactly describes the sound.

The book is well illustrated, and is one which will transport the reader, however much he may be engrossed with the cares of these grim days, to the restful beauty of Nature, ever-changing and ever-young. SETON GORDON.

MEDICAL THEORY AND PRACTICE

The Advancing Front of Medicine

By George W. Gray. (Whittlesey House Publication.) Pp. viii+425. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 3 dollars.

THE medical man who is called in to treat disease is, in most cases, faced with a well-nigh impossible task. He is asked to remedy the defects of an organism, the normal working of which he does not understand. He cannot understand its working until, for one thing, chemistry and the application of chemistry to physiology have advanced further. It is the expedients and ingenuities used and the successes achieved in this task of treatment that Mr. Gray describes; with enough about the nature of diseases to make his description intelligible.

His account of recent advances is vivid and well balanced. For example, in the chapter on cancer he insists that the type of treatment must vary with conditions; he holds up no treatment as a panacea, but points out that any wholly satisfactory treatment must depend on a fundamental understanding of the nature of cancer. He indicates the wide range of medical research, from vitamins to brain potentials, from the inheritance of hæmophilia to the cycle of the virus of swine influenza, through lung worms and earthworms. But would a layman, reading this book, realize what difficulties have been overcome or how much success has been a matter of lucky shots?

One of the most spectacular achievements has been the discovery of the sulphonamide drugs. The difficulty has been to find something that will kill bacteria, once established in the body, without injuring the even more vulnerable host. Specific antisera, one of the natural defences, seemed promising; but, on the whole, they have been disappointing. First it had to be learnt that antisera, to be effective, must contain certain antibodies against the right constituent of the right type of the species of bacteria incriminated. Even now, with these requirements satisfied, it needs statistical analysis to prove the efficacy of sera in the treatment of pneumonia. It might seem possible to make some synthetic chemical with specific actions similar to those of antisera; but our chemistry is not yet advanced enough to solve the secret of these specific actions. So chemists have synthesized drugs in the hope of finding one that is effective; pathologists have tested them on animals and if they seemed successful they have been handed over to physicians to try on human patients. In this process the chemists of the I. G. Farben-Industrie made an azo-dye from *p*-aminobenzene-sulphonamide and handed it to Dr. Domagk to test on animals. Domagk found that the dye protected mice against streptococci. Human beings were then treated with remarkable success. Later it was found that the sulphonamide half of the dye alone was active. The development of this drug has not been based on theory; theories have limped far behind the discovery.

It was Whipple's demonstration that liver is particularly effective in curing anæmia, produced by bleeding, that led Minot to try the use of liver in the treatment of pernicious anæmia. But it seems that the effect on pernicious anæmia is entirely different from that found by Whipple; Minot could not have inferred the amazing cure of pernicious anæmia from Whipple's experiments. It was a lucky shot. As for the shock treatments of schizophrenia, they have much the same theoretical basis as the treatment of a watch by poking with a pin.

This insistence on the importance of appreciation of fundamentals does not imply any underestimate of the value of treatment or of the difficulties that practising physicians and surgeons must overcome. But, without this appreciation, it is not possible to realize the tremendous odds against which the medical man puts up a gallant fight. Mr. Gray's long list of brilliant partial successes may lead people to expect too much, too soon. Could he not have shown how much his front-line fighters are handicapped by lack of supplies and support from the rear in the form of fundamental theories on which treatment can be based?

A few of the faults inevitable in a compilation of this type have crept into the book. Some of the names quoted carry little weight; tuberculin is not a serum; the amounts of vitamin B_1 in meats (p. 45) are incorrect; Prof. J. Mellanby is not "of Oxford".

AN ORIGINAL APPROACH TO THE PROBLEM OF TUMOURS

The Problem of Tumours

The Application of Blastogenic Agents to Ciliates; a Cytoplasmic Hypothesis. By J. C. Mottram. Pp. vii+91. (London: H. K. Lewis and Co., Ltd., 1942.) 7*s*. 6*d*. net.

THE first part of this book deals with changes in form and behaviour of ciliates exposed to agents which increase or decrease the viscosity of the cytoplasm. A wide variety of physical and chemical agents cause similar effects, and, apparently, anything which makes the cytoplasm more viscid tends to inhibit complete fission, so that multinucleate cells are formed. Among other agents, the carcinogenic hydrocarbons can produce this result and thus give rise to clones of abnormal cells. Smaller doses have the opposite effect, and cause increased rate of division, but no recognizable abnormality in the daughter cells. A short review of the literature on abnormality in Protozoa is included. The important point is made that once abnormality has been induced, it may be perpetuated in the absence of the inciting agent.

Another point of greater interest is, that only a small proportion of ciliates in a culture react by recognizable abnormality, but that these cells can transmit the tendency to abnormality indefinitely: whether the abnormal cells overgrow or are overgrown by normal cells in mass culture depends on their relative rates of fission.

These and many other experimental observations are adduced by Mottram in support of the contention that the behaviour of these abnormal Paramecia is analogous to that of tumour cells in mammals. Having presented these facts, he invites the reader to answer this postulate for himself, but makes it clear that he thinks the answer should be affirmative. The gene mutation theory of cancer is briefly discussed and dismissed by arguments which appear to the reviewer to be feasible but not conclusive. A short account is given of an interesting chance infection of a culture of Aspidisca by an unidentified virus, which could be recognized as inclusion bodies in the cytoplasm, and which gave rise to abnormalities in morphology and behaviour similar to those induced by blastogenic agents. Unfortunately, the disease was fatal, and attempts to recover the virus and to infect new cultures failed.

Despite the obviously great differences between unicellular animals and the tissues of mammals, Mottram has assembled a remarkable number of analogous findings in the behaviour of these cells under a wide variety of adverse conditions. He anticipates the criticism "that to draw analogies between the reactions of Protozoa and Metozoan cells is fallacious"; but, whereas these analogies are based on observed facts, some of the assumptions in the postscript are much more open to criticism. However, the author is careful to keep his facts distinct from his theories, and his account of a most original approach to the problem of tumours will be enjoyed by most research workers.

The text is freely illustrated with excellent black and white drawings, and a photographic frontispiece, and there is a bibliography of 103 references.

P. R. PEACOCK.

The Birds of the Liverpool Area

By Eric Hardy. (Merseyside Naturalists' Association Handbooks, No. 1.) Pp. 279+10 plates. (Arbroath: T. Buncle and Co., Ltd., 1941.) 8s. 6d. net.

FIELD ornithologists will appreciate this publication, first for bringing within the confines of a single volume a mass of records hitherto scattered among numerous publications, and secondly for its list of localities where the bird-lover, month by month, can view many of our common species. Part of the preface could, with advantage, have been omitted, as the author devotes it to criticisms of local societies, inappropriate to any scientific work. There is a brief list of local ornithological collections and a short account of Wild Bird by-laws.

The opening paragraphs of the chapter on "Bird Movement and Migration", while containing much that is useful and interesting, are likely to irritate the reader by obscurity of presentation. The chapter on "Bird Census" is not convincing and the author's figures are unbelievably accurate. On p. 48 he states: "The Liverpool Census for 1935 showed 95,000 House-sparrows, 27,000 Starlings, 1,680 Wrens, 1,310 Greenfinches, etc.". Ornithologists who have essayed a bird census, even in a relatively small area in the country, know how difficult it is to arrive at a satisfactory assessment. A census of starlings or sparrows in a large city such as Liverpool will be regarded by most competent ornithologists as unreliable. In compiling the hundred pages of notes on the birds of the Liverpool Area much painstaking search of records must have been involved, but the author's own work would not have suffered by less frequent reference to himself. The volume is illustrated with two maps, one sketch and thirty-one photographs, of which those of the long-eared owl and the lapwing in flight are indeed good. R. K. PERRY.

Transients in Electric Circuits

Using the Heaviside Operational Calculus. By Prof. W. B. Coulthard. (The Specialists' Series.) Pp. viii+203. (London: Sir Isaac Pitman and Sons, Ltd., 1941.) 25s. net.

IT has been said by an eminent American engineer that whereas problems in transient phenomena can only be solved by the application of the calculus, the terrors which this branch of mathematics holds for many engineers have largely been removed by the substitution of the Heaviside operational calculus. Transients may be controlled or fortuitous, but in either case the transient response of a network to excitation can be solved expeditiously and with minimum labour by the technique which has been built up around Heaviside's original methods.

The book under review presents a modern version of this technique in its application to the study of electric circuits consisting of static networks, rotating machines, and component structures. Circuits having both linear and variable parameters are analysed, as well as those which can be regarded as lumped on one hand and in which expansion yields negative powers of the differential operator p, and smooth on the other hand, wherein expansion gives fractional positive powers of p.

Fourier series and integrals are discussed in order to throw further light upon operational methods and to show that the integral yields a long list of operators and their equivalences.

The book is a particularly valuable one to the research worker and to the mathematically inclined engineer.

Nature Abounding

Edited by E. L. Grant Watson. Pp. 350. (London: Faber and Faber, Ltd., 1941.) 10s. 6d. net.

EARTH, air, fire, water, these were the elements as conceived by the philosophers of other days, and under these heads Mr. E. L. Grant Watson, in the present work, has assembled an unusually readable and varied prose selection, representative of the interest with which Nature, to the seeing eye, abounds. He has chosen widely and well. Nature's appeal is for the many, and the compiler has sought his materials, not only in the writings of professed naturalists, explorers and physicists, but also among those of sportsmen, novelists, essayists, gardeners, farmers, and, not least, of the ordinary man. Thus passages from Darwin and Wallace rub shoulders with not less informed observations by Hardy the novelist, Tomlinson the sympathetic voyageur, or Borrow the wayfarer. As he turns the pages, the reader will meet many old and expected friends: Fabre, Hudson, Herman Melville, Izaak Walton and others, and among newer ones, Frazer Darling, Kenneth Graham and Sir James Jeans, to take only a few at random.

The knowledgeable reader, with critical intent, may perhaps peruse this book with the view of testing the compiler's selection against his own recollection of outstanding passages in classic works. Of course, he will find omissions and an unwelcome abbreviation of his own particular favourites, but as Mr. Grant Watson points out, the literature of exploration, travel and natural science in its several branches is so extensive that there can be no question of compiling a complete work. But books of this nature are all too rare, at least so far as the literature of science is concerned, and it seems not impossible that they may have a considerable future, particularly for the specialist worker whose time for general reading is necessarily limited. More is the pity that war-time conditions should condemn such noble text to such indifferent paper.

Oriri

By Marie C. Stopes. Pp. ix+27. (London and Toronto: William Heinemann, Ltd., 1940.) 3s. 6d.

THIS considerable poem has already been reviewed, and favourably reviewed, in various literary journals. It is the love story of a man and a woman in a setting in which objects of Nature, earth, trees and flowers, are harmonized to the central theme. In the Argument, the author tells us that: "Interwoven into the tale is a crystallization of most of what matters fundamentally in the sciences of geology and physiology, in the art of love, and in religion." The poem has, indeed, a scientific content, but so pervading is the artistic sense, so effective the condensation, that the work, which may well be considered as briefly epical, makes its appeal, as the author intended, as poetry.

> "Time's sands shine dripping over
> With burdens of delight
> Garnered from all the past:
> Again the bright sea sparkles on this hill
> And slowly specks of life shed through its blue
> Their fragile vestures, piled to build a land."

Not the least unusual feature of this remarkable work is the brief appendix in which the scientific basis for the imagery used is indicated.

INDIVIDUALITY AND SCIENCE*

By DR. A. F. BLAKESLEE
Director, Cold Spring Harbor, New York

IN looking over my past research activities, the one idea which impresses me most is the individual diversity among living organisms. Our first published investigations had to do with a group of lower fungi which can be included in the name of bread moulds. Among these we discovered that growths which looked alike might differ in sex and in a wide range of chemical responses.

Another example of cryptic chemical differences was furnished by the black-eyed Susan (*Rudbeeckia hirta*). Two races which had yellow instead of purple cones we found could be distinguished by use of strong potash solutions. The treatment turned the cones of one race black and those of the other red.

These examples have to do with innate differences between individuals. Let us consider some examples of differences in which the environment appears to be the controlling factor. One variety of corn has red kernels at the ends of the ears where they are exposed to the sun but white kernels where they are covered. Both the red and the white kernels when planted, however, gave the same kind of offspring. What was inherited was the capacity to become red in a light environment and white in a dark environment.

I used to ask my students to find two apple leaves which were alike. They would start with enthusiasm, but soon would come to realize that two leaves exactly alike could not be found if one used as a simple criterion of identity the possibility of having the two leaves match with all their indentations when one was superimposed upon the other. I would point out that the general pattern of the apple leaf in distinction from that of an oak, for example, was due primarily to its hereditary constitution but that the wide variations in size and shape of leaves and the arrangement of teeth on their edges were modifications of the pattern induced by differences in the environment such as the position of the developing leaf in relation to light and shade, vigour of the twig, its position in the developing bud and other possible factors in internal environment.

With these considerations in mind it is not difficult to realize that probably no two trees in orchard or forest can ever be exactly alike, since in addition to the modifications brought about by variations in environment we have the modifications brought about by differences in hereditary constitution.

Although we can influence the character of organisms through the environment, it is generally believed that we have no control over their heredity. This is not entirely true.

Records this month on seedlings of jimson-weed which had grown from seeds buried for thirty-nine years in soil at the U.S. Department of Agriculture in Arlington seem to be showing an increased rate of mutations. We cannot predict, however, the exact types of hereditary changes that will be induced by ageing and other stimuli. In some cases in the jimson-weed, however, we have used mutated chromosomes with which to synthesize new pure-breeding types with predicted characteristics. By attention to the total number of their chromosomes we have reduced their ability to hybridize with their parental types and hence feel justified in calling them synthesized new species.

By one method we have succeeded in exercising conscious control over heredity, and are able to predict with reasonable accuracy the characteristics of the new types induced through doubling their chromosome number by means of colchicine. In our own and other laboratories new species have been produced by doubling the chromosome number of sterile species hybrids, and new species are known to have been produced by this method in Nature.

In many biological problems affecting human beings, science has had to look to botanists to lead the way. I need to remind you only of the original discovery of the mechanism of heredity by Mendel from his work on garden peas and its later independent rediscovery by three botanists. My interest in human individuality came from my experience with plants. It all started from a botanical problem in 1917 when we were trying to classify the colours of a segregating pedigree of Verbenas. A particular pink-flowered form was very fragrant to me but had absolutely no odour to my assistant. On the other hand, a certain red-flowered Verbena was fragrant to him but not to me. Some of the people in our laboratories agreed with me and some with my assistant. Only a very few found fragrance in both kinds of flowers.

Phenyl-thio-carbamide is a good reagent with which to show innate differences between people. Some of those we have tested need to have the solutions of this reagent more than eight thousand times as strong as others in order to taste it. The inability to taste the commercial crystals is inherited like blue eyes as a Mendelian recessive character; but different grades of taste acuteness have also been shown to be inherited. Numerous tests with other substances only emphasize the wide differences between people in their taste reactions.

The individual reactions of taste are dependent primarily upon innate hereditary factors, and the environment appears of relatively little importance. With smell the condition is quite the opposite. Probably even wider innate differences exist between people in their acuteness of smell than of taste, but environmental factors in abundance prevent the full expression of these hereditary differences. Thus age is a potent factor progressively dulling the sense of smell. A considerable number of people have lost their sense of smell entirely. Temporary conditions of a person, such as a cold in the head, may adversely affect his ability to smell. After being exposed to an odour for a time it becomes no longer perceptible. Olfactory fatigue apparently may be produced even by concentrations too weak to be detected. This is probably the explanation of asphyxiation of people by gradually increasing concentrations of gas which they never detected.

The sense of smell does not play as important a part in man as in many of the lower animals in bringing us information about the external world. There is not a negligible number of people, however, who can distinguish different individuals by odour in the same way in which dogs can distinguish individuals by scent alone. This power is more frequent in children but is often retained into adult life when it is generally concealed on account of the social taboo against speaking of personal odours. Several parents have informed me that certain of their children when young by smelling a handkerchief they had picked up could tell to which member of the family it belonged, but this ability had been lost after they had grown up.

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*Substance of the address of the retiring president of the American Association for the Advancement of Science, delivered at Dallas, Texas, on December 29.

Associations are especially powerful with the sense of smell, but they exist with all the senses. So long as we live we are building up associations and developing our personality through reactions with our environment which express themselves in likes and dislikes. Likes and dislikes are important determiners of our behaviour.

The examples just given of the influence of heredity and environment have been taken from the senses of taste and smell. All the other senses are similarly subject to internal and external influence. I need only mention the innate differences in musical discrimination disclosed by Seashore and the progressive decrease, under the environmental influence of age, in the pitch or number of sound vibrations one can distinguish at a given intensity. There are a host of other responses which contribute to human individuality. Among these are the blood groups, the natural and acquired susceptibilities and immunities to disease and chemical substances, the allergies and the reactions to hormones and vitamins. The Binet and other mental tests have disclosed great differences between individuals in mental equipment.

Votes for Titles in Relation to Position on Ballot, Lancaster, Pa., January 30, 1941

	Titles	Position on Ballot*					Total votes	Per cent of total	Rank
		1st	2nd	3rd	4th	5th			
Males	Why people differ	2·08 A	5·26 E	5·26 D	7·69 C	9·26 B	15	6·02	4
	Differences between people in taste and smell ..	44·4 B	70·83 A	63·16 E	59·65 D	69·23 C	152	61·04	1
	What makes differences in personality	1·92 C	14·81 B	6·25 A	5·26 E	8·77 D	19	7·63	3
	Demonstrations of heredity and environment ...	3·51 D	3·85 C	11·11 B	4·17 A	2·63 E	13	5·22	5
	Why each person lives in a different world ...	23·68 E	22·81 D	17·31 C	20·37 B	16·67 A	50	20·08	2
	Total number	37	59	45	53	55	249	99·99	
	Per cent	14·86	23·69	18·07	21·29	22·09	100·00		
Females	Why people differ	8·70 A	2·17 E	10·53 D	9·30 C	8·57 B	16	7·69	3
	Differences between people in taste and smell ..	62·86 B	47·83 A	65·22 E	57·89 D	60·47 C	122	58·65	1
	What makes differences in personality	4·65 C	... ... B	10·87 A	4·35 E	7·89 D	12	5·77	4
	Demonstrations of heredity and environment ...	5·26 D	 C	5·71 B	6·52 A	10·87 E	12	5·77	4
	Why each person lives in a different world ...	17·39 E	18·42 D	25·58 C	22·86 B	26·09 A	46	22·12	2
	Total number	38	30	52	39	49	208	100·00	
	Per cent	18·27	14·42	25·00	18·75	23·56	100·00		

*Five titles were listed in different orders on five ballots A to E.

Numbers under each position are percentages of votes cast for given title on the ballot indicated by letter at right of figure.

Males: Ballot A was voted 48 times; B, 54 times; C, 52 times; D, 57 times; E, 38 times.

Females: Ballot A was voted 46 times; B, 35 times; C, 43 times; D, 38 times; E, 46 times.

It will be granted no doubt that there are great differences between people in their sensory judgments regarding the world in which they live and that these differences are influenced in varying degree by factors of both heredity and environment. Is this true of man's mental and spiritual judgments? I believe it is even more so. A few simple examples may be given.

At the end of a meeting held at Lancaster, Pa., the audience was asked to select the best title among five which had been suggested for the lecture just given (see table). It might be thought that since all had heard the same lecture, there would have been considerable unanimity in preference. This was not the case, however. Though two titles had more votes than the others, each of the five titles was preferred by a considerable number. Here again we may be reasonably sure that factors of both heredity and environment did influence the mental judgments regarding the best title.

The Supreme Court of the United States is composed of outstanding minds. Their honesty is unquestioned, and they are freed from even the unconscious pressure of political expediency. Here, if anywhere, we should expect unanimity. The Supreme Court, however, from its early history had rendered numerous decisions by a divided vote and in many instances, including some of the most important cases, by a majority of only one. With its broadly changed complexion since early New Deal days, one might expect less diversity in judgment at the present time. This does not seem to be the case judging from a recent news report of the first two decision days of the present term. Within two weeks there were brought in three 5-to-4 and two 6-to-3 decisions. None of the justices during this time had failed to enter at least one dissent and all except two had more. We cannot here attempt to analyse the elements in these differences in judgments. Such blanket terms as liberal and conservative suggest the influence of innate disposition and also of such environmental factors as advancing age. If we remember our experiments with taste and smell we may agree that judgments of drinkers regarding the taste of beer and judgments of the Supreme Court regarding issues of law cannot help differing because men both are born different and have differences thrust upon them by their environment.

Differences in expression in art, music and literature can likewise be attributed to influences of heredity and environment. I have personally been interested in studying the manner in which trees have been used in art. Styles in method of representation are evident, but the artists differ in the way in which trees appeal to them. Some are interested in individual trees, others in groups. Some prefer trees in the foreground, others in the background or in the middle distance. There are differences also in the species of trees which different artists like best.

We have given examples of differences in plants and animals such that no two individuals are exactly alike and have classified the causes of these differences into the interacting factors of heredity and environment. We have shown that both heredity and environment are likewise responsible for the diversities in man, not only in his physical structure and sensory reactions but also in his mental and moral judgments. Every thought and act of our lives is influenced by these two factors. Man has used his knowledge of heredity and environment to mould plants and animals to his personal advantage. Can this be done with man himself? To some extent, yes, but the way is not so clear.

I know of no adequate evidence that man to-day is a better animal physically or mentally than at the dawn of history. While man's biological evolution during these five thousand years and more has seemed to lag, and at the present time has appeared to many to have been thrown into reverse, man's environment has changed markedly even within our own lives. Conscious control of human heredity, though a desired goal, will at best be slow even if our genetic knowledge were adequate for the task. Changing man's environment gives promise of more rapid betterment of human individuals, and in this effort we are far from reaching diminishing returns.

But the facts of individuality and the relative influence of heredity and environment upon personality must be carefully estimated in any rational campaign for permanent social betterment. Such knowledge has power to revolutionize our ideals and practice in social and religious justice, charity and education, methods of legislation and forms of government. Methods of education, for example, have been severely criticized for mass regulations which fail to take adequate account of individual excellences. Similar criticisms come from the so-called exact sciences, mathematics, physics and chemistry, against the difficult, less exact biological sciences, botany and zoology, and some would even deny the name of science to those most difficult studies of man's social behaviour. For years the educational world has been struggling with the problem of how best to deal with the increasingly recognized differences in mental ability, differences which, like those we have found in taste reactions, are of two kinds: a difference between general marked ability and general mediocrity and a difference between ability in certain lines such as mathematics, science, art or literature.

I recently wrote to the sixteen living past presidents of our Association and asked them if they could satisfy the enclosed New York State requirements for teaching in the State secondary schools. Not one of the past presidents of the American Association for the Advancement of Science would be allowed to teach science in a New York high school without further preparation since none had taken the required instruction, which included such subjects as the psychology, history, philosophy, principles and practice of education. One past president properly remarked that not all presidents would have been good secondary school teachers. It is a fact, however, that more than a quarter have had secondary school teaching experience, but could not now qualify under present requirements. This is not at the present time a serious deprivation of the freedom of these men, but some believe the State methods of selecting teachers place undue emphasis upon relatively unimportant requirements. Some educators have told us that, in the balance between method and subject-matter they believed the pendulum had swung too far towards method.

Blanket regulations may make for ease of administration, but too great uniformity may preclude the assets of individuality. Uniform laws throughout the States would have certain advantages, but they might not be equally well adjusted to local environments and might prevent profitable experiments in local government. The increased means of communication throughout the world appear a mixed blessing. They tend to standardize our thoughts and behaviour in a common mould, but at the same time to decrease the material expressions of individuality available for social evolution through natural selection.

Opposition to totalitarianism is not merely because it attacks man's rights but also because it suppresses his personality. Individuality is the kernel of democracy, the biological basis of the struggle for freedom. When we fight for individuality we fight on the side of Nature. Recognition of individuality and all that it implies especially concerns us as men of science. Even if science were again persecuted and driven under cover, as it was in the Middle Ages, there would still be some brave inquiring minds. But science cannot flourish without freedom of thought and its expression.

Why do I emphasize the value of individuality to science? Because I believe science is the great hope of mankind.

In speaking of science and men of science it should be clear I am not confining attention to the professionals. Whoever by observation or experimentation is responsible for increased knowledge of the world in which we live is a servant of science and contributes to the welfare of mankind. In this connexion it is appropriate to mention that in Colonial times keen observers had discovered the causal connexion between barberry bushes and infestations of wheat rust and had passed laws in Massachusetts for the eradication of barberries long before botanists learned that a necessary stage in the life-cycle of this rust is confined to the barberry.

Science is under fire for the suffering brought about by its applications, especially in the present war. Science is in no position to disavow its responsibilities in the problems of peace and war. As in epidemics of disease due to ignorance of medicine we need not less but more medical knowledge, so in seeking a cure for the scourge of war we need not less but more science. The remedy we trust may ultimately be found by that most difficult of all biological sciences—the study of motives and human behaviour. Science can reply to its critics that the applications of science are merely tools which men with good or bad motives use for their good or evil ends. The same can be said of printing. Even if we admit the responsibility of science for deaths due to its applications we will find that its applications have brought about even greater savings of life. The legend to a reproduction of the title page of Jenner's paper on vaccination published in 1798 reads: "The application of the facts presented in this paper has probably saved more lives than the total of all lives lost in war." The statement is easy to believe, since it has been estimated by Haggard that in the hundred years preceding Jenner's paper, sixty million people in Europe died of smallpox.

In war itself science has not been alone destructive, as may be seen from figures supplied by the Surgeon General's office regarding the annual death-rate per thousand in the United States Army for the Mexican War, the Civil War and the first World War. Deaths due to battle injuries increased from 15 per thousand for the Mexican War through 33 for the Civil War to 53 for the World War. The death-rate due to disease, however, decreased from 110 through 65 to 19 for the World War. The net result is that the total death-rate actually declined, from 125 in the Mexican War through 98 in the Civil War to 72 per thousand in the World War. It is a satisfaction to feel that though implements of war have increased in destructiveness, those who are fighting to preserve our free way of life may not be subjected to greater risks than our forefathers assumed when they too fought for their country.

It can scarcely be emphasized too strongly that it is not man's material comforts nor even the alleviation of his physical pains which are the greatest gifts of science to mankind. Science has freed men's minds. Foremost among liberating ideas is the belief that there is order and law in the universe and that this order can be discovered by questioning Nature herself. Such belief was rare in the Middle Ages when processes of Nature were generally attributed to supernatural causes: winds and storms to demons, comets and epidemics to the wrath of the Almighty towards a sinful world, and investigations of Nature were persecuted by both Church and State as Satanic magic and sacrilegious questioning of the acts of God. The Copernican theory widened our physical horizons and showed our earth as a tiny speck in a universe of worlds. The theory of evolution brought a unity to our ideas of the organic world. The discovery of the mechanism of inheritance allowed an evaluation of the contributions of heredity and environment to the personality of individuals. The experimental method with adequate controls is the most valuable tool science has yet developed. Its understanding and use in daily life would mean more than all the scientific facts that schools can teach.

Science has helped to free man's soul. It has broadened the horizons of religion and given it a new point of view away from the old intolerant, materialistic theology when men sought their own salvation from selfish hope of heaven or fear of hell and persecuted or even killed those who did not conform to the authority of orthodox beliefs. Elimination of such incumbrances has left to religion a freer field for the cultivation of its great spiritual values.

Science has banished much of ignorance and superstitution, but much remains. Recently in New York's Pennsylvania Station I purchased seven different magazines on astrology. One of them, and this not the best seller according to my newsdealer, I found had a monthly paid circulation of more than 132,000 copies. The readers of these astrological journals are part of our democracy and help to form the policies of our Government. Other examples need not be given to show that the scientific method has not yet saturated our land.

If we consider past efforts to better mankind, it is clear that good intentions are untrustworthy criteria of service to humanity. The biblical criterion—"By their fruits ye shall know them"—is biologically sound doctrine and still the best test. The attempts to suppress independent thought and study of Nature in the Middle Ages, and up to the not distant past in our own country, were inspired by noble motives, but they put civilization back by many centuries. The Crusaders had a lofty purpose but a trivial objective: the capture of an empty tomb, with all too slight appreciation of the teachings of Him whom the tomb had held.

During the plague of the seventeenth century when twenty-five million people or a quarter of the population of Europe died of this dread disease, there were doubtless, as there should have been, hospitals and other organized efforts to minister to the sick and dying. We can imagine the scant attention that would have been then paid to a request for a grant for a scientific study of the life habits of such creatures as rats, fleas and the wriggling animalcules which Leeuwenhoek discovered at about this time in drops of putrid water. Yet our knowledge of rats, fleas and bacteria is one reason why centuries later pest hospitals are not found in London and we no longer dread the plague. The illustration given is an example of the unsuspected value of knowledge in apparently unrelated fields. Many other examples could be given of the service of science to human welfare, a service which is often indirect. The ancients used human sacrifices to ensure bountiful harvests. Now we use commercial fertilizers for this purpose and find them more efficient. In the old days people fought yellow fever and smallpox by church rites and religious processions. Now we fight these diseases by killing mosquitoes and by vaccination. Formerly thousands of people were executed on the ground that they were witches. Science has proved that witchcraft does not exist. It would be difficult to give from history as striking examples of success in direct efforts to improve the condition of mankind without the aid of science.

Knowledge is power also in our efforts towards human betterment. We must learn the facts about the environment in which we live if we wish to adjust ourself into harmony with it. Efforts against Nature are doomed to failure despite high motives. It is for this reason we believe that in a rational programme for human betterment science—the free search for truth—is in the long run the best investment. If what I have said is true, it lays upon us all, both scientist and layman, a responsibility for the advancement of science, free and unhindered as a service to mankind. Think where we would have been now if in the Dark Ages men like Copernicus, Galileo, Albertus Magnus, Roger and Francis Bacon among other inquiring minds had been able to carry on their scientific investigations in an atmosphere of intellectual freedom. Our most difficult sciences might now have reached the stage occupied by biology, for example, and we might already have found a remedy for our present sick civilization.

How can science best be fostered? I need offer only a few suggestions.

Science, in common with all intellectual pursuits, needs tolerance, freedom from restraint and a recognition of the value of individuality. Men differ widely in their capacities for research. A great need therefore in the advancement of science, as of other intellectual endeavours, is to devise means for discovering the exceptional abilities at an early age and giving such abilities exceptional opportunities in order that their span of effective service with its social values may be prolonged.

The public, whom science serves, knows all too little what science really means. The magic and gadgetry of scientific applications rather than the methods and ideals of science make the great appeal. Yet the ideals and methods would help society reach judgments on the basis of ascertained facts rather than through emotional appeal and personal profit, and would transform our daily lives if universally applied. Think what a chance would come if our representatives in legislative halls should open each session with the prayer of Huxley: "God give me strength to face a fact though it slay me"—and really mean it.

A common comment of a layman after visiting a laboratory and having research explained to him is: "What great patience scientists must have!". The real thought appears to be how can reasonably intelligent men, as men of science seem to be, be content to spend time in such trivial and uninteresting details. The layman seems to feel as he might in watching a small child picking up little white pebbles laboriously one by one and putting them into a bucket, and then taking them out again one by one in the same painstaking manner. Yet this same layman sees reason in taking a stick and whacking a diminutive white ball over a field, alone or in company with others, and each time he gets it into a little sunken bucket he takes it out again and whacks it to another bucket of the same dimensions. Science as well as golf is a sport to those who play the game and there is a chance of some bit of human value when the game is done.

In the promotion of human welfare through the advancement of science, men of science and the public have a common interest and may have a common share. I believe the American Association is especially adapted to furthering these common interests and could profitably undertake a study looking towards the development of a more effective programme that would serve the aims of man of science and layman alike.

In the United States as nowhere else patrons of art, literature and science have made investments in human good. The yields in benefits secured have varied much, but sometimes have been slight because the investments have been unsound. We trust that those of philanthropic intent who wish to promote human welfare through the methods of science will subject their donations to as careful checks as they would a financial investment in order to ensure a profitable yield in the way of scientific dividends. A newly established National Science Fund is in position to serve as a clearing house for advice on the probable scientific dividends which may be expected from investments in science.

Although we do, each of us, live in different and more or less separate worlds of our own, I trust we shall ultimately be able to acquire a social organization as orderly as the constellations of other worlds. In our fight for individuality and freedom in this War and in the peace to come, I do not despair. The experimental method has demonstrated we must use force without stint to show that freedom and political morality as well as personal honesty really pay. We still cherish the faith that the free search for truth by the methods of science has power to rebuild the world and will prevail.

SRINIVASA RAMANUJAN*

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SRINIVASA RAMANUJAN was a mathematician so great that his name transcends jealousies, the one superlatively great mathematician whom India has produced in the last thousand years. He was born at the village of Erode in Tanjore on December 22, 1887. His parents were Brahmins of high caste, but very poor, and without any means of direct access to influential people. Srinivasa's mathematical ability was soon recognized at the high school at the neighbouring town of Kumbakonam, which he entered at the age of seven. We are told with what delight the big sixth-form boys found at the bottom of the school a youngster who was ready to do all their hard sums for them, and with what mixed feelings he read in their books theorems which he had discovered for himself. In 1903, a few months before he left the high school with a scholarship to the Government college in the same town, there came into his hands a "Synopsis of Mathematics", a book containing the enunciations of some six thousand theorems, for the most part without proofs, and Ramanujan set to work systematically to establish the results. Geometry did not appeal to him, but in algebra and calculus he found himself in a magic world, in which he lived for the next ten years. In proving one formula he discovered many others, and he began to compile a note-book, the first of the note-books which afterwards became famous.

Unfortunately, Ramanujan lived too completely in his new world. College regulations could secure his bodily presence at a lecture on history or physiology, but his mind was free, or, shall we say, was the slave of his genius. We know now that to describe one hour which Srinivasa Ramanujan spent on mathematics as mis-spent is absurd, but to the college authorities he was just a student who was neglecting flagrantly all but one of the subjects he was supposed to be studying. The penalty was inevitable: his scholarship was taken away, and he was told that he must repeat the year's course. So he ran away, and what he did and how he lived for the next few years is not on record. He returned to college for a short time, but failed to secure any academic qualifications.

Away from college, Ramanujan's wants were few, and for five years he was able to satisfy them without interrupting his investigations. But in 1909 he married, and needed definite employment. His unfortunate college record was a serious obstacle, and he obtained introductions from one to another of three Indian mathematicians, Ramaswami Aiyar at Tirukoilur, Seshu Aiyar in Madras, and Ramachandra Rao at Nellore, to whom in turn he produced his note-books as evidence that he was not the incorrigible idler his failures seemed to imply. Ramachandra Rao has given an account of Ramanujan's first interviews with him:

"Several years ago, a nephew of mine, perfectly innocent of mathematical knowledge, spoke to me: 'Uncle, I have a visitor who talks of mathematics. I do not understand him. Can you see if there is anything in his talk?' And in the plenitude of my mathematical wisdom, I condescended to permit Ramanujan to walk into my presence. A short, uncouth figure, stout, unshaved, not over-clean, with one conspicuous feature—shining eyes—walked in, with a frayed note-book under his arm. He was miserably poor. He had run away from Kumbakonam to get leisure in Madras to pursue his studies. He never craved for any distinction. He wanted leisure; in other words, simple food to be provided for him without exertion on his part, and that he should be allowed to dream on.

"He opened his note-book, and began to explain some of his discoveries. I saw quite at once that there was something out of the way, but my knowledge did not permit me to judge whether he talked sense or nonsense. Suspending judgment, I asked him to come over again, and he did. And then he had gauged my ignorance, and showed me some of his simpler results. I asked him what he wanted. He said he just wanted a pittance to live on so that he might pursue his researches. It is a matter of considerable pride to me that I was in some way useful to this remarkable genius in his earlier days."

Ramachandra Rao's interest took the most practical and generous form. He sent Ramanujan back to Madras so that he might work at the University there, and for a little more than a year he maintained him at his own expense. Many people, in India and in England, have been proud that they helped Ramanujan; of them all, perhaps his first benefactor deserves the highest praise.

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* A talk broadcast in Hindustani in the Indian service on April 22, 1941.

Ramanujan, unwilling to be a burden for life, took in 1912 a clerkship under the Madras Port Trust, but Ramachandra Rao soon let the authorities of the Trust know what sort of a clerk they were employing, and thenceforward every assistance was given to Ramanujan. Francis Spring, the chairman of the Trust, made his post into a sinecure, and resolved to take the first opportunity of discussing the case with someone competent to appreciate Ramanujan's work. The opportunity came less than a year later, when an official visit was paid to Madras by Gilbert Walker, then director-general of observatories in India, a first-class mathematician trained in Cambridge. Walker's verdict, though he did not see Ramanujan and had only specimens of his work and not the note-books themselves to inspect, was unhesitating, and he wrote to the University authorities in Madras in the most emphatic terms: "The University would be justified in enabling S. Ramanujan for a few years at least to spend the whole of his time on mathematics, without any anxiety as to his livelihood." The words "at least" in this sentence are very remarkable. The University responded willingly, and with as little delay as was compatible with the fact that the situation was so far outside all precedent that explicit permission had to be secured from the Government of the Presidency, and on May 1, 1913, Srinivasa Ramanujan entered the Presidency College in Madras to practise as a virtue that single-minded devotion to mathematics which had been a vice in Kumbakonam nine years earlier.

Meanwhile, Ramanujan's name had become well known in Cambridge, the home of mathematics in England. G. H. Hardy, then a young lecturer at Trinity College and now the dominant figure among English mathematicians, who was destined to be closely associated with Ramanujan in the future, has sometimes said that Ramanujan was his discovery, but the truth is that Ramanujan chose Hardy. In a booklet dated 1910, Ramanujan found for the first time formulæ like some of his own, and acting on the advice of Seshu Aiyar, he wrote on January 16, 1913, a letter to the unknown author. No one who was in the mathematical circles in Cambridge at that time can forget the sensation caused by this letter. An obscure Indian clerk was appealing for advice because he was inexperienced, for help in the publication of his theorems because he was poor. "But only", he said, "if you are convinced that there is anything of value." Of the theorems sent without demonstrations, by this clerk of whom we had never heard, not one could have been set in the most advanced mathematical examination in the world. It must be confessed that the first suggestion was that the letter was a hoax, that the theorems must be familiar theorems skilfully disguised, but this explanation was soon abandoned, for there were some formulæ in the letter for which it certainly could not account. Of these Hardy has said, "They defeated me completely; I had never seen anything in the least like them before. A single look at them is enough to show that they could only be written down by a mathematician of the highest class. They must be true because, if they were not true, no one would have had the imagination to invent them." A great mathematician who has discovered formulæ of an entirely novel kind does not use them to mystify his friends.

Hardy answered the letter promptly, and Ramanujan knew that at last his intellectual solitude was at an end. His friends in India encouraged him and supported him, but none of them had the knowledge to bring him the human satisfaction of being understood and appreciated; to Hardy he wrote, "I have found a friend in you who views my labours sympathetically."

But if Ramanujan was contented because he had escaped drudgery and loneliness, in Cambridge it was clear that his genius was still in danger of being wasted. It is not that any brain could do mightier work anywhere than Ramanujan's had performed at Kumbakonam in the carefree days before 1909, but that mathematics is cumulative and inevitable. If the architect of the Taj Mahal had designed a different tomb for Arjumand Banu, the most beautiful building in the world to-day would not have come into existence. But if Euclid had not discovered that the number of prime numbers is infinite, nevertheless that same theorem would have been discovered long ago by somebody else. Moreover, the world of mathematics is no richer if somebody who has not heard of the theorem discovers it to-day for himself. Of Ramanujan's work before 1913, Hardy has written that it was inevitable that a very large part of it should prove on examination to have been anticipated. "He had been carrying", he says, "an impossible handicap, a poor and solitary Hindu pitting his brains against the accumulated wisdom of Europe." It is the accumulation in Europe that we have to emphasize; Ramanujan was beginning every investigation at the point from which the European mathematicians had started 150 years before him, and not at the point which they had reached in 1913. Close contact with mathematicians of the highest class was an urgent necessity for him, but he did not yet know this, and when Hardy asked if he would go to Cambridge, Ramanujan declined, reluctant to lose caste, and deferring to opposition on the part of his parents, whose objections were religious, and of some of his friends, who saw in this invitation a mean attempt to transfer to the English University the glory that belonged to Madras.

I visited Madras myself in the opening weeks of 1914. After my first lecture Ramanujan was introduced. We sat down, and he turned the pages of a note-book. Two days later he turned the pages again, and after our third meeting he said, "Perhaps you would like to take it away with you." The astounding compliment took away my breath. The priceless volume had never before been out of his hands: no Indian could understand it, no Englishman was to be trusted with it. The truth was, of course, that the English were objects of suspicion not as individuals but as components of the governing machine; I came from outside the machine, and, for no other reason than that, I enjoyed an overwhelming advantage which was grossly unfair. Richard Littlehailes, the professor of mathematics, in particular, had done and was to do far more for Ramanujan in Madras than I did.

Ramanujan's trust having been won so completely, I raised immediately the question of Cambridge, and found to my delight and surprise that Ramanujan needed no converting and that his parents' opposition had been withdrawn: in a vivid dream his mother had seen him surrounded by Europeans and heard the goddess Namagiri commanding her to stand no longer between her son and the fulfilment of his life's purpose. Lest he should be harassed presently by attempts to dissuade him, I addressed myself to the task of convincing his friends that the proposal was in Ramanujan's own interest. I wrote at once to

Hardy that the intangible obstacles had disappeared and that he must see that financial provision was made; I should try to obtain grants in Madras, but if I failed the money must somehow be found in England. I do not know what account I gave of Ramanujan and the note-books, but I made it abundantly clear that if Ramanujan was willing to come, financial difficulties simply must not be allowed to interfere. For a moment Hardy faltered. "Be careful what you promise", he wrote, and he forwarded a cautious memorandum of the "We-have-heard-of-these-untaught-geniuses-before" type, from the India Office in London. I claim no credit for ignoring this warning and laughing at Hardy's endorsement of it; I had seen the note-books and talked with Ramanujan, and Hardy had not. Moreover, while letters were travelling between Madras and London it was becoming likely that all the money wanted would be found in India. Littlehailes introduced me to everyone who carried weight in the University or in the civil administration; everywhere I talked of Ramanujan, explained as I have tried to do now the importance to him of a stay in Cambridge, and urged generosity. On January 28 I addressed to the University authorities a prophetic memorandum which began: "The discovery of the genius of S. Ramanujan of Madras promises to be the most interesting event of our time in the mathematical world", and ended: "I see no reason to doubt that his name will become one of the greatest in the history of mathematics, and the university and city of Madras will be proud to have assisted in his passage from obscurity to fame." Littlehailes drafted proposals in detail, and within a week the University, with the approval of the Government, had created a scholarship ample to maintain Ramanujan in Cambridge and his wife and mother in Kumbakonam. A few days later I left Madras.

It was in April 1914 that Ramanujan arrived in Cambridge, where he lived in my house until residential accommodation became available for him in July in Trinity. He felt the petty miseries of life in a strange civilization, the vegetables that were unpalatable because they were unfamiliar, the shoes that tormented feet that had been unconfined for twenty-six years, but he was a happy man, revelling in the mathematical society which he was entering, and idolized by the Indian students. The outbreak of war in the summer of that year affected profoundly his development. Most of the mathematicians whom it had been hoped that he would soon know disappeared from the University on war service of one kind or another; only Hardy remained, but Hardy had an unexpected amount of time at Ramanujan's disposal, and the two were constantly together. "I had to try to teach him", says Hardy, "and in a measure I succeeded, though obviously I learnt from him much more than he learnt from me." If Ramanujan's published papers are far narrower in scope than the note-books, if many of the ideas which had been born in India were neglected in England, it is because Hardy could guide Ramanujan rapidly and accompany him profitably only in regions of mathematics where he was himself at home. It was the War which separated Ramanujan from mathematicians with interests different from Hardy's but not alien to his own, and threw him into an association with Hardy so intimate that the two strands of their joint work cannot always be distinguished.

For three years, alone and in collaboration with Hardy, Ramanujan produced mathematical papers of the highest quality in rapid succession. Then he fell a victim to tuberculosis. Immediate return to India was impossible, for the war-time voyage was risky and uncomfortable. After a year's constant attention in English nursing-homes, his health showed some improvement, and he enjoyed a brief period of brilliant invention. It was at this time that the two highest academic honours in England, which had never previously been conferred on an Indian, were conferred on Ramanujan. Early in 1919 he returned to Madras: travel was again easy, and the purpose of his sojourn in Cambridge had been accomplished, his family and his friends were waiting for him, his native land was impatient to do him honour. To everyone's dismay, the voyage or the return to a warm climate caused a relapse; for a year every care was lavished on him, but he died in Madras on April 26, 1920.

During his last year he worked slowly and in pain, but the work showed the old invincible originality. His last letter to Hardy, dated January 12, 1920, is singularly reminiscent of the fateful first letter, for it, too, contained a multitude of formulæ with only the obscurest hints of the theory from which they were derived. He was developing his last theory until he died, and it is a measure of his genius that fifteen years elapsed before this theory was understood and made public.

I must not end without making an attempt to describe the man himself. In figure he was a little below medium height, and stout until emaciated by disease; he had a big head, with long black hair brushed sideways above a high forehead; his face was square, he was clean shaven, and his complexion, never really dark, grew paler during his life in England; his ears were small, his nose broad, and always his shining eyes were the conspicuous feature that Ramachandra Rao observed in 1910. He walked stiffly, with head erect and toes out-turned; if he was not talking as he walked, his arms were held clear of the body, with hands open and palms downwards. But when he talked, whether he was walking or standing, sitting or lying down, his slender fingers were for ever alive, as eloquent as his countenance. He had a fund of stories, and such was his enjoyment in telling them that in his great days his own irrepressible laughter often swallowed the climax of his narrative. He loved a paradox, but I do not know of any that he invented; the paradoxical element in some of his own early work must have made him aware that the wildest nonsense of to-day may receive a logical interpretation to-morrow. He had serious interests outside mathematics, and was always ready to discuss politics or philosophy. Loss of caste was a price he was prepared to pay for coming to England, but he kept the price as low as he could by adhering as closely as circumstances permitted to the observances of his religion, and in particular by maintaining the strictest vegetarianism. "When I go back", he said to me once, "I shall never be asked to a funeral", and if he spoke with a sigh there was no sense of pollution mingled with his regret. In everyday life he had an instinctive perfection of manners that made him a delightful guest or companion. Success and fame left his natural simplicity quite untouched. To his friends he was devoted beyond measure, and he devised curiously personal ways of showing his gratitude and expressing his affection. The wonderful mathematician was indeed a lovable man.

Had Ramanujan not left India he might be alive to-day, but he would have had always the sense of power and frustration, not of power and accomplishment. Death, too, was a frustration, but the life's purpose of which his mother dreamed was at least in part fulfilled, and it is better to be frustrated by unsought death than by life. So Srinivasa Ramanujan believed, for he told me just before he left England that he had never doubted that he did well to come.

DOMESTIC ENTOMOLOGY IN WAR-TIME

By DR. J. R. BUSVINE
London School of Hygiene and Tropical Medicine

IT is a curious paradox that the cyclopean evil and stupidity of a world war stimulate intelligent co-operation within smaller spheres. Anyone who has read the pages of NATURE during the present War will be aware that men of science are giving serious thought to their organization, status and general relations with society. Progress has certainly been made in the allocation of research problems, collaboration between individuals and application of results. Unfortunately, much of what has been done lies under a war-time ban of secrecy, but anyone who knows something of the work of the Biological War Committee (see NATURE of February 28, pp. 227 and 234) is aware that this is so. It must, however, be admitted that the symposium on "Domestic Entomology" held by the Association of Applied Biologists on February 20 revealed a lack of coordination of this particular type of problem. The pest species discussed were not linked on anatomical, physiological or even ecological grounds but rather from considerations of the organization of advice and control. Domestic pest problems are constantly confronting sanitary inspectors and medical officers who usually pass them on to one research institute or another. It would seem desirable that the Ministry of Health should retain an entomologist to deal with such specialized problems.

Interest in some domestic pests waxes and wanes with external events. Thus, research on lice and scabies is stimulated by war and to some extent lapses in peace-time. The drive on slum clearance a few years ago attracted attention to that perpetuator of slum life, the bed-bug. In addition to *ad hoc* research, a long-range ecological study of the bug was initiated, the results of which are only recently available[1].

A sound film on "Malaria", produced by the Shell Oil Co., was shown. This film was designed to be shown to non-technical people to give a clear picture of the causes and control of the disease without being dull or too complex. It not only succeeded brilliantly in this but also included pictures of great interest to the professional entomologist (particularly those of the female mosquito laying eggs and the realistic animated diagrams).

Dr. Busvine described some recent applied research which seems to provide a safeguard against epidemics of lice and the terrible diseases associated with them. While people are all able to get regular changes of undergarments, the body louse is not likely to spread rapidly, and occasional cases of infestation can be dealt with by improvements on methods used in the War of 1914–18. At any time, however, unhygienic conditions may arise as a result of severe bombing, invasion or other hazards of 'total' war which may favour the louse. If this pest becomes widespread it is exceedingly hard to eradicate, as was found in Flanders in the War of 1914–18 and in other subsequent epidemics. The difficulty, which consists in rapid reinfestation of deloused persons, can now be overcome by the use of lasting insecticides, applied in various ways, which 'proof' a person for a month after treatment. These methods, which have been thoroughly tested on verminous men, were illustrated by a short amateur film.

Dr. Busvine concluded by pointing out that the head louse, which is very much more common, is very closely allied to the body louse and may possibly be a disease vector. Similar lasting insecticides would be of value for this pest, applied as 'medicated' hair dressings.

The incidence of scabies in Great Britain is on the increase—a fact that cannot entirely be ascribed to war conditions because the increase started several years ago. Dr. K. Mellanby gave an account of some interesting recent research on the transmission of scabies. The experiments were made with the amicable collaboration of pacifist volunteers and scabetic soldiers.

Some controversy has arisen over the usual mode of transmission of the parasite; some holding that it is very largely indirect, others using that provoking word 'venereal'. It would be exceedingly difficult to discover what actually is the main mode of transmission, but Dr. Mellanby's experiments have certainly shown that indirect transmission is very much less efficient than even moderately intimate contact. Attempts to transmit the parasite on blankets or clothes were only successful one or two percentage of two or three hundred trials, whereas the mite was readily transferred between two men sleeping in the same bed, both wearing pyjamas.

Major Johnson reviewed the scabies problem from the statistical point of view. Although it is not possible to find all stages of the mite, the oviparous females can be counted with accuracy. Examination of scabetic cases revealed a remarkably low population compared with the numbers theoretically possible (estimating from the reproductive rate and length of the life cycle). Less than five live females were found on 50 per cent of the cases and only 5 per cent had more than sixty. Populations on individuals seldom rise sharply and sometimes decline to zero.

When we are living in the country we are often troubled by various families of biting flies. Dr. Kearns proposed thiocyanates as deterrents for our protection but warned us that what was effective for midges (Ceratopogoninæ) might be quite inefficient for 'clegs' (Tabanidæ). Some country houses are subject to periodic invasion by swarms of muscids and chloropids seeking to hibernate. They are very enterprising and persistent and it seems to be impossible to keep them out. The only remedy seems to be regular spraying by pyrethrum or thiocyanates in paraffin at the right time of year.

Dr. Kearns described a serious fly problem that has arisen in several bombed sites in our towns and cities. Wrecked food stores provided ideal breeding-grounds for houseflies and blowflies. Until it was possible to clear up the debris, a degree of control was achieved by weekly spraying with a tar oil emulsion and the use of an atomized spray for adults in neighbouring houses and shops.

Judging from inquiries at the Forest Products

Research Laboratory, furniture beetles are more prevalent than is often believed. Dr. Fisher pointed out that war-time furniture storage is likely to spread the trouble even further. Control of insects in wood is exceedingly difficult, but prevention of attack is much more feasible as a result of the researches on the physiology and dietetics of the pests. For example, it has been found that the so-called 'dry' wood-borer, Anobium, really needs a fairly high moisture content to flourish. Also the attack of Lyctus beetles can be prevented by elimination of starch.

Mr. Fox Wilson dealt with two pests less harmful but of considerable importance as nuisances. It is not generally realized that the invasion of houses by earwigs may actually render them uninhabitable. The reasons for such invading swarms are obscure, but they often occur on new building sites, and various connecting factors have been suggested.

The ants which trouble us in our houses and institutions may either be tropical species which have become 'domesticated' or invaders from the garden.

Both ants and earwigs can best be controlled by baiting, but whereas an arsenic-syrup bait is most effective against ants, the earwigs are most attracted by a bran-fluosilicate-fish-oil mixture.

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[1] Johnson, C. G., *J. Hygiene*, **61**, 345 (1942).

OBITUARIES

Prof. Hans Spemann

The death of Hans Spemann, of Freiburg-im-Breisgau, at the end of 1941, brings to a close a life-time of work which threw a new and most revealing light on the great problem of the development of biological form.

Spemann was born in 1869. After leaving school he spent a few years in his father's business and in the performance of his military service, before beginning the study of medicine at the Universities of Heidelberg, Munich and Würzburg. He held his first position as a lecturer at the last-named University, passing from there to become professor of zoology at Rostock in 1908. During the War of 1914–18 he held a chair at the Kaiser Wilhelm Institute in Berlin, and in 1919 he was called to the professorship at Freiburg-im-Breisgau, which he held until his retirement in 1935, the year in which he was awarded a Nobel Prize for medicine.

Spemann's work did not cover a wide range of topics. His second paper, published in 1898, dealt with the development of the Amphibia; and this remained his field of investigation throughout his whole life. His great achievement was to bring into fruitful co-ordination the two, in themselves inconclusive, lines of attack which had been opened up in the casual investigation of development. On one hand, the studies of Roux and Driesch on the developmental potentialities of the first-formed blastomeres of the egg, although they tackled the major problems of the formation of the animal as a whole, seemed to lead only to a sterile paradox. On the other hand, Roux's notion of dependent differentiation appeared to suggest a plausible causal mechanism for development, but the one known example of it, and that a somewhat doubtful one, was concerned with the development of a single organ, the lens of the eye. Spemann entered both these fields, with his famous constriction experiments on the early cleavage stages of Triton, and his early grafting experiments on the optic rudiments of the same form. By 1918 he was able to bring forward his concept of the 'organization-centre', and demonstrate that the morphogenesis of the embryo, in its main outlines as well as in its details, is the result of interactions between different regions of tissue. For the next fourteen years, Spemann was the leader of a school, which rapidly filled in the outlines of what had come to be called 'embryonic induction'; their work was summarized in his Croonian Lecture of 1927. In 1932 he participated in the next major step forward, the beginning of the physico-chemical investigation of the process.

Although his work was one of the most important influences in the final discredit of vitalism, Spemann was never one of those who hoped that the discovery of the organizer would rapidly enable us to reduce the problem of biological form to a few simple chemical statements. His attitude was, in fact, much more a biological than a physico-chemical one. The extreme caution with which he formed his conclusions, joined with intense concentration on a narrow field favourable for an attack on fundamental problems, enabled him to lay a foundation on which the science of experimental morphogenesis can be securely based.

C. H. Waddington.

The Right Hon. Lord Salvesen, P.C., K.C.

Edward Theodore Salvesen brought to his profession and to his hobbies the vigour and enthusiasm bequeathed him by his Norwegian forebears. His profession carried him, by way of the University of Edinburgh, the Scots Bar and a sheriffdom, to a judgeship in the Court of Session of Scotland. His hobbies and his public interests were too many to mention, but he accomplished much for the veterans of the War of 1914–18 (in which his three sons were killed), he helped to reform the divorce law of Scotland, and he was a strong advocate of public-house reform. But his lasting memorial is the Scottish Zoological Park.

It was largely owing to his advocacy and to his energetic leadership as president of the Zoological Society of Scotland, founded in 1909 for the establishment of a national zoological park, the advancement of zoology, and the study of the native animals of Scotland, that the Park was opened in 1913. At that time it was a new venture in British zoos. The site of seventy-four acres with its mansion-house, gardens, fine trees and abundant natural exposures of rock invited broad and picturesque treatment, and the late Sir Patrick Geddes and Mr. F. C. Mears prepared the scheme for laying out the grounds.

Developments, carried out step by step under Lord Salvesen's guidance, as the funds of the Society warranted, have resulted in a park of great attraction, with spacious paddocks, and rocky dens in which the animals live and are seen to the best advantage.

Lord Salvesen presented to the Society its acclimatization house adapted for some less hardy creatures, and was instrumental in obtaining from the Carnegie Trustees the grant which built the Carnegie Aquarium. His and his brother's connexion with the whaling industry in South Georgia enabled them to bring together in the Park what must have been a unique collection of penguins in captivity. For at its best the collection comprised twenty-eight king penguins, which regularly bred and reared young, in addition to the ringed, gentu, rock-hopper and black-footed species. The War, alas, has destroyed some of the glory of that interesting group, as it has interfered with many of the accustomed inhabitants of the Park; but Lord Salvesen's experiment in planning a modern zoological garden has been abundantly justified and will continue for long to give to its many visitors pleasure mingled with instruction.

After a short period of ill-health Lord Salvesen died on February 23, still a man of vigour, in his eighty-fifth year.

JAMES RITCHIE.

WE regret to announce the following deaths:

Sir Henry Brackenbury, vice-president of the British Medical Association and, during 1927–34, chairman of the Council, on March 8.

Dr. H. D. Curtis, head of the Department of Astronomy and director of the Observatory, University of Michigan, on January 8, aged sixty-nine.

Prof. H. W. Foote, professor of physical chemistry in Yale University, on January 14, aged sixty-six.

Mr. P. G. Redington, forest supervisor of the U.S. Forest Service, formerly chief of the U.S. Biological Survey, on January 12, aged sixty-three.

Mr. F. J. Selby, C.B.E., secretary of the National Physical Laboratory during 1918–32, on March 5, aged seventy-four.

NEWS and VIEWS

The Poulkovo Observatory

INFORMATION that the Poulkovo Observatory had been severely damaged in the German bombardment of Leningrad was first received in a special message to the men of science of Great Britain broadcast from the besieged city on October 8, 1941, by Prof. Vassily Ogorodnikov, professor of physics in the University of Leningrad, who was fighting in the ranks of the Red Army defending Leningrad. The Observatory lies some twelve miles south of Leningrad, not far from the railway line from the German frontier to that city. The shelling of the Observatory appears to have been deliberate, and from later information it is learnt that its destruction is practically complete.

The Poulkovo Observatory was founded in 1839 by the Emperor Nicholas and recently celebrated its centenary. The first director was F. G. W. Struve (1793–1864), who had been the director of the Dorpat Observatory during 1818–1839. He was commanded by the Emperor to design and erect, almost regardless of cost, the most perfect and complete observatory that he could devise. Struve had a zeal for refined and precise methods of observation and, in addition, an inventive mechanical and engineering capacity, and he took full advantage of this unique opportunity. His "Description de l'Observatoire Astronomique Central de Pulkowa" is a work which, in the words of Sir David Gill, "no one, even in the present day, who may be charged with the design and erection of a great observatory, can afford to neglect". From the time of its foundation, the Poulkovo Observatory has taken a leading part in fundamental astronomy, for which its high latitude particularly fitted it. The standard refraction tables used in the reduction of astronomical observations are the Poulkovo refractions, based on Poulkovo observations. The fundamental observations made there have always been planned with care and characterized by their high accuracy, so that in the formation of a fundamental system of star places the Poulkovo catalogues receive very high weight.

The instrumental equipment of the Observatory included a Repsold meridian circle, an Ertel-Merz vertical circle, a Repsold prime-meridian transit instrument, a Repsold-Clark 30-in. refractor of 46 ft. focus, a Repsold-Merz 15-in. refractor of 27 ft. focus, in addition to numerous smaller instruments. F. G. W. Struve retired in 1861 and was succeeded as director by his son, O. W. Struve (1819–1905), who retired in 1889. The two Struves between them practically laid the foundations of double-star astronomy, by their discoveries and observations of double stars. J. O. Backlund (1846–1916), who was director during 1895–1916, made important investigations on Encke's Comet, the period of which (about 3·3 years) shortened by 2½ days between 1819 and 1914. In a memoir that is a classic, he showed that the motion of the comet is retarded in a narrow region not far from perihelion by a resistance of some sort, and that this resistance has decreased rather abruptly several times. The library of the Poulkovo Observatory was one of the most complete astronomical libraries in existence, and its treasures included many of the manuscripts of Kepler. It is hoped that steps had been taken before the German attack to remove the valuable books and manuscripts to a place of safety. The Poulkovo Observatory was an institution of which the Russians were justly proud, and men of science in all countries will share with them their grief at its destruction.

Scientific Co-operation between Great Britain and the U.S.S.R.

THE Parliamentary Secretary of the Ministry of Information (Mr. Ernest Thurtle, M.P.) opened a conference of British scientific and technical institutes on March 9 at which Sir John Russell, adviser to the Soviet Relations Branch of the Ministry of Information, took the chair. The conference, which took place in the rooms of the Royal Society, was called to discuss an intensification of the exchange of technical and scientific information between the U.S.S.R. and Great Britain. Some sixty scientific organizations and learned societies of Great Britain sent representatives to the conference, and it was decided to set up a standing committee to assist the Ministry of Information in this work and to act as a clearing-house between organizations in Great Britain and their opposite numbers in the U.S.S.R. A representative of the Soviet Government is to be invited to join the subcommittee.

Government Plans for Reconstruction

WITH the completion of the recent Cabinet changes, it is announced that Sir William Jowitt, who was Solicitor-General, has been appointed Paymaster-General, in succession to Lord Hankey. The duties hitherto performed by the Minister without Portfolio in connexion with the study of post-war reconstruction problems will in future be carried out by the Paymaster-General, who has been charged with general responsibility for organizing and co-ordinating the work on reconstruction problems now being carried out by the various Departments of State. For this purpose he will have at his disposal the special section which has been engaged on this work under the Minister without Portfolio. Arrangements will continue whereby reconstruction questions are considered by a committee of Ministers containing representatives of the political parties. Mr. H. G. Strauss, M.P., has been appointed an additional Parliamentary Secretary at the Ministry of Works and Buildings. In this office, Mr. Strauss will be responsible under the Minister for the planning functions of the Ministry.

The general responsibility hitherto entrusted to the Minister without Portfolio in regard to export surpluses and allied post-war relief will in future be exercised by the President of the Board of Trade. It is also officially announced that Sir Frederick Leith-Ross, chief economic adviser to the Government, will continue to direct the organization concerned with export surpluses and allied post-war relief, which will now be attached to the Board of Trade instead of to the Ministry of Economic Warfare, and he will relinquish his post as Director-General of the Ministry of Economic Warfare.

Scientific Invention at the Service of the Community

MR. P. H. B. LYON, headmaster of Rugby School, was in the chair when Capt. John Langdon-Davies addressed the Rugby branch of the Association of Scientific Workers on March 5 on "Scientific Invention at the Service of the Community". After referring to Prof. J. D. Bernal's book on "The Social Function of Science" as giving a detailed picture of the organization of science and the imperfections consequent upon a system of production for profit, Capt. Langdon-Davies passed on to a consideration of the effects of social phenomena that influence education more than do schools and universities, such as advertising, with its creation of false appetites for 'streamlined' refrigerators. The need is for social planning, including a planned attack by men of science on the most urgent problems, not only of war but also of peace. Capt. Langdon-Davies looks to the development of substitutes for raw materials such as rubber, as a means of wiping out the pools of semi-slave cheap native labour which he regards as one of the prime causes of imperialistic conflict. Only by raising the standards of life of the peoples of Asia and Africa, he contended, can we hope for permanent social security. He pointed out that science exercises an influence on spiritual values, suggesting that the moral theology of the medieval Schoolmen was not unscientific but based on the incorrect science of Aristotelean physiology. He called for a "sense of reverence" from scientific workers. In conclusion, he insisted that scientific method must be applied to politics and economics, demanding, however, that we must preserve our criteria and standards of scientific truth in politics.

Centenary of General Shrapnell

ON March 13, 1842, Lieut.-General Henry Shrapnell, the distinguished artillerist and inventor, died at his home, Peartree House, Southampton, at the age of eighty, having spent his whole career in the improvement of guns and projectiles. Born at Bradford-on-Avon on June 3, 1761, he entered the Royal Artillery at the age of eighteen and continued to serve until 1825, when he was retired with the rank of major-general. In 1837 he was promoted lieutenant-general. Fused hollow shells had been used since the time of Vauban, but Shrapnell was the first to introduce shells filled with musket bullets and with a bursting charge for firing from long guns. His first demonstration was made at Gibraltar in 1788, but it was not until 1803 that Shrapnell shells were adopted by the Board of Ordnance. In that year Shrapnell carried out a large number of firing experiments at the works of the Carron Company, Falkirk, and the company was given orders for large numbers of this new projectile. Shrapnell shells were used at the Siege of Surinam in 1803, in the Peninsular War and at the Battle of Waterloo. The inventor spent many thousands of pounds of his own money on the experiments; he was given a pension of £1,200 in 1814. At his death Shrapnell was buried in the family vault in the parish church of Bradford-on-Avon, where a tablet erroneously gives the year of his death as 1847.

Uses of Colloidal Graphite Solutions

THE general scarcity of metals lends a special interest to the use of dispersions of colloidal graphite in water for making non-metallic bodies electrically conducting. On glass or similar substances which can be thoroughly cleaned with chromic acid, the graphite dispersion can be applied with a soft brush. Glass elbows and intricately shaped parts of evacuated systems can, by this method, be fitted with conducting shielding. Absorbent surfaces such as wood veneer or rubber tubing are best saturated to a slight depth below the surface with a dilute solution and then coated with the more concentrated form. It is suggested that by this means cabinets or even whole research rooms can be electrically shielded by applying the liquid by brush-painting or air-spraying followed by air-drying. Soft-cloth polishing, by forcing the particles into closer contact, automatically increases electrical conductivity. Leads for connexions or for earthing the screens are sealed into the glass or are fitted externally before applying the liquid. In Great Britain the product is sold as 'Aquadag' by Messrs. E. G. Acheson, of 9 Gayfere Street, London, S.W.1. Details were published in 1936 by B. H. Porter in NATURE, 137, 1034, and in the *Review of Scientific Instruments*, 7, 101.

The Hannah Dairy Research Institute

THE activities of the Hannah Dairy Research Institute, Kirkhill, Ayr, described in its twelfth annual report, are, as would be expected, chiefly concerned with the maintenance of the country's milk supply. The problem is approached from two main aspects, namely, the biological and the technical. Under the former category come investigations as to the provision of adequate home-grown feeding-stuffs and the avoidance of disease in the herd. Grass silage has been successfully produced in large quantities on the Institute's farm; but dried grass, though a first-class product from the feeding point of view, is regarded as probably not economic for the moderate-sized dairy farm. The possibility of improving the protein ration by feeding non-protein nitrogen compounds such as urea, with the idea that it would be converted into protein in the rumen of the animal, is under investigation. No far-reaching results are yet announced, but when roughly one third of the protein of the production ration was supplied in this form, the health, milk yields and body weights of the cows remained unimpaired during the six-week trial period. As regards disease prevention, control measures against mastitis have been extended, and the use of sulphanilamide administered orally has met with marked success. Dried milk products are being studied on the technical side, factors affecting their solubility and keeping quality receiving special attention. It appears that the addition of antioxidants to the precondensed milk before drying considerably increases the keeping quality of the resultant powder.

Earthquake at Santa Barbara, California

FROM *Earthquake Notes* of December, 1941, we learn that a severe earthquake occurred at Santa Barbara, California, at 11.51 p.m. P.S.T. on June 30, 1941. This was followed by a swarm of after-shocks which continued for several days. Shocks of any consequence ceased to occur at about noon on July 3, but three shocks were reported on this date. A preliminary report from the seismological laboratory at Pasadena gives the epicentre location as 34° 20′ N., 119° 35′ W. This position is about eight miles off shore in a south-easterly direction from Santa Barbara. Damage was estimated at about 150,000 dollars. Maximum intensity was about VII or VIII on the modified Mercalli scale. Accelerograph records of this shock were obtained at Santa Barbara, Long Beach and Vernon. The record obtained at Santa Barbara is being analysed by integration methods and the results are expected later.

"Davitamon-Five" Vitamin Tablets

MESSRS. ORGANON LABORATORIES, LTD., Brettenham House, Lancaster Place, London, W.C.2, have recently put on the market a new preparation of vitamin tablets named "Davitamon-Five". This preparation is intended for those people who wish to ensure that they are ingesting an adequate quantity of essential vitamins. The tablets are intended for the day-to-day prophylaxis and treatment of mild hypovitaminoses; and since a number of research workers have made it clear that specific avitaminotic symptoms are abolished more rapidly when the diet is adequate in the other vitamins, they can also be used to provide a suitable background for an intensive single-vitamin therapy. Each tablet contains: 1,000 I.U. vitamin A; 50 I.U. vitamin B_1; 200 I.U. vitamin C; 200 I.U. vitamin D; 0·5 mgm. *PP* factor of the B complex. A sample of the tablets can be obtained from the above laboratories.

Science Masters' Association: Annual Meeting

THE forty-first annual meeting of the Science Masters' Association will be held at Rugby School during April 8–10, under the presidency of Mr. P. H. B. Lyon, headmaster of Rugby School. The subject of the presidential address will be "English in the Science Course". Lectures will be delivered by Prof. M. L. E. Oliphant on "Recent Practical Applications of Nuclear Physics" and by Mr. L. J. F. Brimble on "Human Biology in Education". Prof. L. T. Hogben will deliver the Science and Citizenship Lecture. A discussion on "Science in Post-war Education" will be opened by Mr. E. G. Savage. Further information can be obtained from Mr. W. Askhurst, Grammar School, Stretford, Lancs.

Announcements

PROF. A. W. M. ELLIS, professor of medicine, University of London, has been appointed director of research in industrial medicine by the Medical Research Council.

SIR EDWARD APPLETON, secretary of the Department of Scientific and Industrial Research, will deliver the twenty-sixth Guthrie Lecture of the Physical Society on March 20. He will speak on "Ionospheric Influences on Geomagnetism".

MR. W. T. HALCROW will deliver the thirty-second May Lecture of the Institute of Metals on May 31 at the Institution of Mechanical Engineers. The title of the Lecture will be "Water Power and its Application to the Production of Metals".

MR. S. BAIRSTOW, of the Chemical Research Section, Research Department, of the London Midland and Scottish Railway, has been awarded the Herbert Jackson Prize for 1941, for a paper entitled "The Relation between Calorific Value and the Road Performance of Producer-Gas Vehicles".

AT the request of the Minister of Agriculture, the National Institute of Agricultural Botany has set up a special Seed Production Committee the duty of which will be to take all possible steps to stimulate, co-ordinate and ensure home seed production. The chairman of the Committee is Mr. W. Gavin, agricultural adviser to the Ministry of Agriculture. The executive officer is Mr. Leslie E. Cook, and all communications should be addressed to him at the National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

A COPY of the third (revised) edition of a pamphlet on "The Colorimetric Determination of Oxidation-Reduction Balance" has been received from the British Drug Houses, Ltd., Graham Street, London, N.1. This gives in simple language a summary of the theory of oxidation-reduction processes and potentials, and of oxidation-reduction indicators and their uses in volumetric analysis and in several fields of work, including biochemistry and soil chemistry. Copies of this useful pamphlet can be obtained free of charge on application to the British Drug Houses, Ltd.

THE Lady Tata Memorial Trust is prepared to consider applications from workers in Great Britain for grants or scholarships for the year beginning October 1, 1942, for research on blood diseases, with special reference to leukæmia. Under present conditions it is not possible to deal with new applications from workers overseas. Inquiries must be addressed to the Secretary, Scientific Advisory Committee, Lady Tata Memorial Trust, c/o London School of Hygiene, Keppel Street, London, W.C.1, not later than March 31.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Excretion of Ketosteroids in Human Pregnancy Urine in Relation to the Sex of the Fœtus

It has long been known that when a cow gives birth to calves, one a male and the other a female, the male will grow into a normal bull while the female may be a freemartin. The freemartin is zygotically a female and the external genitalia and mammary glands, though modified, are usually of female type, but the gonads histologically resemble testes rather than ovaries and there is a tendency for the Wolffian ducts to persist whereas the oviducts are absent or incomplete. Fusion of the placentæ with anastomosis of their blood vessels is an essential factor in producing the freemartin. Because of the common blood supply the testicular hormones of the male have free access to the female twin and cause her reproductive organs including her gonads to conform towards the male type. Parabiosis experiments in animals and also histological examination of embryonic gonads in several species seem to show that in embryos the androgenic cells of the male gonad begin to secrete before the ovary has become completely differentiated, and that the ovary does not produce secretion until a much later stage of development. It seems also that the androgens produced in early embryonic life are abundant enough to cause profound and permanent changes in the ovaries of a female twin.

These considerations suggested that it might be of interest to examine the urine of women in the early stages of gestation to discover whether the testes of a male embryo might produce enough androgen to cause a recognizable increase of androgen in the mother's urine. The most likely time for a positive result in such a test would be in early pregnancy, since involution of androgenic tissue in late pregnancy has been observed in some species.

Samples of pregnancy urine were obtained from twenty women and the ketosteroids estimated colorimetrically. Collection of complete 24-hour specimens proved impracticable and the estimations were carried out on samples of morning urine. All urines were collected 8–12 weeks after the last menstrual period. It was afterwards determined that fourteen women were bearing a male fœtus; their average ketosteroid excretion was 26·2 mgm. per litre. The six women bearing female fœtuses had an average excretion of 14·6 mgm. per litre. When account is taken of the wide range of the individual values in these two series, it is apparent that the difference between the mean excretions is not significant ($t = 1{\cdot}8$). The highest value observed in a female pregnancy was 19·8 mgm. Seven of the male pregnancy values exceeded 20 mgm., the highest value being 80 mgm. per litre. Assays carried out at later stages of the pregnancies showed that initially high ketosteroid contents tended to fall whereas moderate assays remained substantially unchanged.

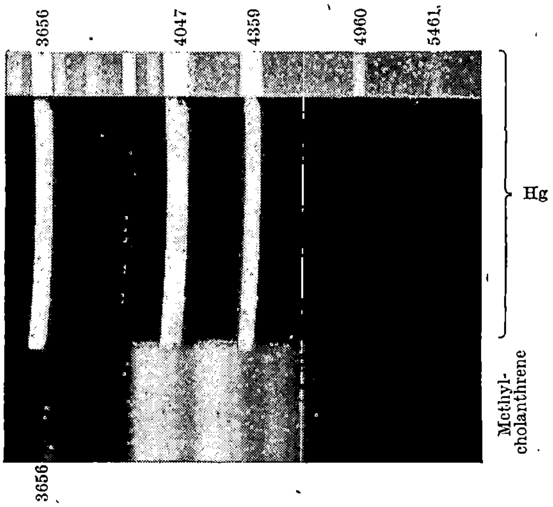
Details of these experiments will be published elsewhere. We are unable to continue this work at the moment and the purpose of this note is to suggest that it would be interesting to examine a larger series. We realize fully the limitations imposed by the smallness of the present series, but the facts that (*a*) the seven very high values reported above all occurred in male pregnancies, and that (*b*) in the later stages of pregnancy these values tended to fall to the general average for all the cases, are in agreement with the hypothesis that the source of the extra excretion lies in the gonad of the fœtus. The possibility that the fœtal adrenal cortex plays some part cannot, of course, be excluded.

HAROLD BURROWS.
DOUGLAS H. MACLEOD.
F. LL. WARREN.
The Chester Beatty Research Institute,
The Royal Cancer Hospital (Free),
London, S.W.3.
Feb. 24.

Fluorescence of Methylcholanthrene

The letter on "Fluorescent Lipoidal Spectra of Human Tissue" in NATURE of February 14, p. 193, requires comment upon several points.

Dr. Penn's statement that I reported . . . "that most of the carcinogenic hydrocarbons studied were highly fluorescent and they produced characteristic bands in the regions 4000, 4180 and 4400 A" . . . is, I regret to point out, incorrect. The regions of the spectrum quoted referred to the bands shown by the carcinogenic tars and tar fractions, and by the complex carcinogenic mixture prepared from tetralin by Prof. Kennaway. Further work has only emphasized that the various carcinogenic hydrocarbons have different fluorescence spectra and that there is sufficient correlation between their chemical structure and spectra to make identification by this means a very useful experimental aid. Thus 1 : 2 : 5 : 6-dibenzanthracene and the "1 : 2 : 7 : 8-dibenzanthracene" prepared by E. Clar certainly gave the same fluorescence spectrum, but Prof. Cook proved that the compound which Clar thought to be 1 : 2 : 7 : 8- was really 1 : 2 : 5 : 6-dibenzanthracene. When Cook did synthesize 1 : 2 : 7 : 8-dibenzanthracene, its spectrum was found to be completely different from that of the 1 : 2 : 5 : 6- isomer.



HG SPECTRUM AND FLUORESCENCE SPECTRUM OF METHYLCHOLANTHRENE.

Dr. Penn finds that cancer tissue lipoids produce a far stronger fluorescence than do the lipoids of non-cancer tissue, and that the spectra are different. The number of specimens which have shown these differences is not stated. Such a result would be most agreeable, but here we have so far failed to show any differences in fluorescence between fatty extracts of cancer and non-cancer tissues. I have not used the method of extraction which Dr. Penn considers to yield a solution of "lipo-protein" in acetone. However, this subject is still under investigation.

Dr. Penn's fluorescence spectrum of methylcholanthrene suggests that he has been the victim of an unfortunate mistake. A sample made from deoxycholic acid by Prof. Cook in 1933 and a synthetic sample made in 1938 give very much the same fluorescence spectra : three massive bands extending over about 800 units of wave-length, the well-marked mercury line 4047 lying near the interval between the first and second bands (see figure). This hydrocarbon fluoresces very powerfully in the most sensitive region (violet) of the photo-sensitivity curve of an ordinary plate, and a concentration of 1 in 400,000 is quite enough to give a strong negative in the spectrograph.

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Biotin as a Possible Growth Factor for Insects

IT has been shown for several insects, namely, Lucilia[1], Drosophila[2] and Tribolium[3], that the larva requires a growth factor which is contained in the water-insoluble fraction of yeast and is not fat-soluble. This can be easily demonstrated with *Tribolium confusum.* This beetle, which normally breeds on wholemeal flour, grows almost equally well on a diet consisting of casein, glucose, yeast, cholesterol, salts and water added to make a water content of about 15 per cent. If a water-soluble yeast extract (prepared according to Chick and Roscoe[4]) is supplied instead of yeast, growth is very much retarded (1) (see accompanying table), but normal growth is restored by adding the water-insoluble fraction of yeast (2). The same result has been obtained with the following three species of beetles which are all common pests on stored food : *Sitodrepa panicea, Lasioderma serricorne* and *Silvanus surinamensis.* The need for an 'insoluble' factor in yeast seems, therefore, to be of general occurrence in insects. This factor is not fat-soluble, because the adding of a chloroform-soluble extract of yeast (3) or of wheat germ oil (4) only very slightly improves diet (1). It is not considered to be entirely absent from yeast extract because in that case development would presumably be impossible. This view is supported by the fact that tripling the amount of yeast extract improves the diet considerably (5). A water-soluble liver extract shows about the same deficiency (6) as the corresponding yeast extract (1). The filtrate of autoclaved yeast improves diet (1) and so does marmite (7) (which is virtually an autolysed yeast extract).

BASAL DIET: 50 parts casein, 50 parts glucose, 1 part cholesterol, 1 part McCollum's salt mixture and 15 parts yeast extract.
20 larvæ in each test.
Temperature 25° C., relative humidity 70 per cent.

Additions to basal diet		Period in days during which first 10 pupæ were formed
(1)	None	45–53
(2)	Insoluble yeast	26–31
(3)	Chloroform extract of yeast	40–46
(4)	Wheat germ oil	40–44
(5)	Three times quantity of yeast extract	34–41
(6)	None, but liver extract instead of yeast extract	43–56
(7)	Marmite	32–36
(8)	Lecithin	40–45
(9)	Vitamin-H concentrate from yeast ...	34–40
(10)	Biotin-concentrate from yolk	29–34
(11)	None, but starch instead of glucose ...	30–33

These and other properties of the insoluble factor suggest a similarity to György's vitamin H which has recently been shown to be identical with biotin and been recognized as an essential food factor for the rat[5]. Kögl[6] has shown that commercial lecithin always contains traces of biotin and, in fact, diet (1) is slightly improved by the addition of lecithin (8). György[7] prepared a vitamin-H concentrate from the water-insoluble residue of liver by autoclaving and treating the resultant solution in turn with acetone and with alcohol. The same treatment applied to the insoluble fraction of yeast yielded an extract which, when added to diet (1), improved it very considerably (9). Kögl's[6] original isolation of biotin from yolk was started by boiling in water and removing in turn all that precipitates with acetone and alcohol. The same treatment applied to the yolk of one egg yielded a solution which when added to diet (1) improved it almost to the efficiency of diet (2) which contained the insoluble fraction of yeast (10).

These results make it very likely that the 'insoluble' factor in question is in fact biotin. The final proof must, of course, wait until a test can be performed with pure biotin in place of insoluble yeast fraction. Although biotin has recently become available in the United States, we have so far not been able to procure a sample and have to postpone this experimentum crucis until it arrives.

It is noteworthy that a 'biotin' deficiency cannot be demonstrated with Tribolium when the carbohydrate in the diet is starch instead of glucose (11). This suggests that the purest samples of starch which are available contain sufficient traces of biotin, and presumably explains why a biotin deficiency of rats has hitherto only been demonstrated as the so-called egg-white injury (that is, in a diet which contains large amounts of egg-white). It has often been stated that rats can be grown well on a diet in which the vitamins of the B-group are supplied in a water-soluble yeast extract. Such diets should be, on paper, deficient in biotin. It may be suggested that this deficiency is usually made good by traces of biotin in starch which is almost invariably the carbohydrate used in dietary experiments. In fact, it has recently been shown that diets in which starch is replaced by sucrose are apt to give inferior results[8,9].

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[1] Hobson, R. P., *Biochem. J.*, **27**, 1899 (1933).

[2] Tatum, E. L., *Proc. Nat. Acad. Sci.*, **25**, 490 (1939) ; **27**, 193 (1941).

[3] Fröbrich, G., *Z. vergl. Physiol.*, **27**, 335 (1939).

[4] Chick, H., and Roscoe, M. H., *Biochem. J.*, **24**, 105 (1930).

[5] György, P., du Vigneaud, V., *et al.*, *Science*, **91**, 243 (1940) ; **92**, 62, 609 (1940) ; **93**, 477 (1941) ; *J. Biol. Chem.*, **140**, 643 (1941).

[6] Kögl, F., and Tönnis, B., *Z. physiol. Chem.*, **242**, 43 (1936).

[7] György, P., *et al.*, *J. Biol. Chem.*, **131**, 733, 745, 761 (1939).

[8] Oleson, J. J., Bird, H. R., Elvehjem, C. A., and Hart, E. B., *J. Biol. Chem.*, **127**, 23 (1939).

[9] Chick, H., Macrae, T. F., and Worden, A. N., *Biochem. J.*, **34**, 580 (1940).

A Photographic Method of Estimating the Mass of the Mesotron

WE have described[1] a method of estimating the mass of secondary particles with heavy ionization tracks in photographic emulsion which are due to some component of the cosmic ray. The method is based upon the determination of the kinetic energies of these particles and of protons with the same initial velocities, which according to our assumption produce tracks with the same mean grain spacings in the emulsion.

The method used requires to be amended in two ways:

(1) In the application of Williams's formula for scattering[2], which can be written as $\overline{\theta} = A . \frac{Ze^2}{W}\sqrt{Nt}$ in a medium with atoms of one kind, Z is the nuclear charge and N the number of atoms per unit volume. For the photographic emulsion, we have to sum up for the scattering due to the different kinds of atom with different values of Z. For this purpose we used a mean value of Z defined as $\overline{Z}.N = \overset{n}{\underset{1}{\Sigma}} Z_k N_k$. Since the value of $\overline{\theta}$ is deduced from that of $\overline{\theta^2}$ which is defined as $\frac{2}{\pi}$ times the mean square of θ, the value of Z to be used in our formula is the root mean square of Z, namely, $\overline{Z^2}.N = \overset{k}{\underset{1}{\Sigma}} Z_k{}^2 N_k$. While $\overline{Z}$ is 6·2, $\sqrt{\overline{\overline{Z}^2}}$ is 11·3. This was pointed out to us by Dr. H. J. Bhabha in a private communication, for which our thanks are due to him.

(2) The second correction refers to the way the lengths of the ionization tracks in the emulsion were grouped together in the table given in our previous communication. There was a certain arbitrariness in our method of grouping, which while giving a series of more or less concordant values of the mesotron mass, is not sufficiently randomized. In the present calculation all the tracks are grouped together for which the mean grain spacings lie within definite ranges of 6–5, 5–4, 4–3, 3–2 μ. Further, we have used three more photographic plates exposed to neutron radiation from a radium-beryllium source to obtain a more accurate calibration curve for proton tracks.

The recalculated values of the mesotron mass are given in the accompanying table, for which A has been taken to be 3·69. If the more accurate formula (40) of Williams is taken, in which a correction for the finite nuclear radius is introduced, the value of A becomes 4·14, which raises the value of μ by 12 per cent.

Mean grain spacing 10^{-4} cm.		6–5	5–4	4–3	3–2	Mean value
Value of mesotron mass μ in units of m_0	Plate A	221	160	236	(1723)	217 ± 30
	B		316	355		336 ± 19·5
	C	278	318	342	(1743)	313 ± 18·6

Plate A was kept under air, and B under 20 cm. of water at Sandakphu, and plate C at Phari Jong, Tibet, in the Post Office building under a roof thickness of 2½ ft. of mud and wood. The consistently high values of mesotron masses found with plates B and C are probably due to the presence of proton tracks in these plates, due to collision of primary neutrons with hydrogenous matter. This is further evidence of the paucity of fast primary protons in comparison to the number of similar neutrons in the cosmic ray. In all the plates for mean grain spacing 3–2 μ, the tracks are largely due to protons; in this region the proton calibration curve is not accurate.

We have also determined the mass of the mesotron from the curvatures of the pair tracks in the emulsion; the value is found to be 186·0 m_0. Owing to the shortness of range in the emulsion of most of the star-tracks, similar determinations have not been possible with such tracks.

It is to be noted that in the calculations with Williams's formula we have used individual values of θ, rather than its mean value; this is conditioned by the nature of our investigation. The values of μ so obtained will be distributed statistically about the true value; the mean value of μ obtained for the set of observations with plate A will approximate closer to the true value than any of the individual ones.

As stated in our previous communications, the importance of these results lies in the support they give to the view that multiple mesotron production in a single act by some component of the cosmic ray is possible, the principal contributor being, according to our results, the neutron. This is in accordance with the views of Heisenberg. Further interest has been directed to this process by the recent investigations carried out in the United States, which have led to an attempt by Carlson and Schein[3] to explain the totality of the cosmic ray processes taking place in the earth's atmosphere as being due to the impact of a single primary particle, the proton. According to their views, the initial step consists in the creation in one explosive act of a large number of mesotrons, in which the primary proton by interaction with a nuclear particle in the upper atmosphere loses all its energy. So far as the creation of mesotrons is concerned, protons and neutrons are about equally effective. Our results appear then as an experimental support of Carlson and Schein's assumption. The further question then arises whether the fast neutrons which are found in the earth's atmosphere are entirely of secondary origin.

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[1] NATURE, **148**, 259 (1941).

[2] Williams, E. J., *Proc. Roy. Soc.*, A, **169**, 539 (1939).

[3] Carlson, J. F., and Schein, M., *Phys. Rev.*, **59**, 840 (1941).

Self-incompatibility in Polyploid Forms of Brassica and Raphanus

IN a recent paper Lewis and Modlibowska[1] have suggested that in autotetraploid pears pollen of the constitution S_1S_2 is capable of functioning in $S_1S_1S_2S_2$ styles—thus a self-incompatible diploid of the constitution S_1S_2 will produce by somatic doubling a self-compatible autotetraploid $S_1S_1S_2S_2$. In colchicine experiments I have observed many times that no such change occurs in *Brassica Rapa*, *B.*

campestris and *Raphanus sativus*—in these three species the autotetraploid and the diploid branches of colchicine-produced diploid-tetraploid sectorial chimeras have always both been self-incompatible. It was also possible in these cases to show that one was dealing with normal self-incompatibility and not with some disturbance produced by the colchicine treatment, since seeds could be obtained from both the diploid and autotetraploid branches by either bud pollination or the stigma-shaving method of Sears[2]. Lewis has also found that autotetraploid branches of *Œnothera organensis* are self-incompatible like the diploid.

The above Brassica results do not in any way invalidate Lewis and Modlibowska's suggestion that in pears S_1S_2 pollen can grow down $S_1S_1S_2S_2$ styles, since the mechanism of self-incompatibility in Brassica is different from that in pears. In Brassica, as is shown by the stigma-shaving method, self-incompatibility is due to the outer layers of the stigma while in pears it is due to the slow growth of pollen-tubes inside the style.

Brassica chinensis autotetraploids behave in the same way as those of *B. campestris* except that *B. chinensis* shows cyclic compatibility[3]. In *B. oleracea* both self-compatible and self-incompatible plants occur in the diploid[4] and both types have also been found in the autotetraploids.

It would also be interesting to know whether amphidiploids from a cross between two self-incompatible diploid Brassica species would be self-compatible since the three allotetraploid species, *B. Napus*, *B. carinata* and *B. juncea*, are self-compatible. The following two results suggest that they might be self-compatible. No self-incompatible plants have been found in the Cambridge *Raphanus sativus* × *Brassica oleracea* amphidiploids although these plants have been selfed for three generations[5,6]. It is not, however, known whether the two original parents were self-incompatible, but on the other hand, Kakizaki[4] was unable to obtain *Brassica oleracea* plants which would breed true for self-compatibility. Also amphidiploids from the cross self-incompatible *B. chinensis* × self-compatible *B. carinata* are self-compatible[7].

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[1] Lewis, D., and Modlibowska, I., *J. Genet.*, **43**, 211 (1942).

[2] Sears, E. R., *Genetics*, **22**, 130 (1937).

[3] Stout, A. B., *Amer. J. Bot.*, **18**, 686 (1931).

[4] Kakizaki, Y., *Jap. J. Bot.*, **5**, 133 (1930).

[5] Howard, H. W., *J. Genet.*, **36**, 239 (1938).

[6] Howard, H. W., Ph. D. thesis, Cambridge (1939).

[7] Howard, H. W., *J. Genet.*, **43**, 105 (1942).

Search for Petroleum in Australia

MY attention has been directed by Mr. Frederick Chapman to Mr. H. B. Milner's review which appeared in NATURE of January 4, 1941, p. 13. Certain aspects of the Lakes Entrance field were obviously not available to Mr. Milner at the time. His reference to emulsified oil is now known to have no relevance—natural unemulsified oil exists throughout the glauconite (the reservoir rock); when this oil is baled or where it has risen to or near the surface, there is no emulsion. The emulsion only occurs where water has been allowed to enter the wells and when pumping is resorted to. Under those conditions, due to the churning action of the pump used, an oil-in-water emulsion occurs.

Then again, Mr. Milner, in quoting from Government reports, says the trouble with Lakes Entrance is that there is no natural pressure to cause oil to flow in the wells when the sands are penetrated. Actually (*vide* Ranney-Fairbank report on tests of Imray Well made in the presence of Dr. Raggatt, geological adviser, Commonwealth Government, and State Mines Departmental officers), the position is as follows:

"However, in the Imray Well, which was drilled only 21 feet into the glauconite, the fluid has been rising for 695 days; the rate of rise at first was 5 feet (5·4 gallons) per day, total height of the column in the hole was 1,164 feet and the top of the column stood at 110 feet from the surface. The column was still rising on July 13th this year. The fluid column consisted of 173 feet of water and 991 feet of oil (1,100 gallons by measurement in tanks). It appears, therefore, that the fluid produced was approximately 85 per cent oil. Because of the fact that the fluid rose in the well to the height attained and would undoubtedly have risen, in time, to about 100 feet above sea level, it is indicated that instead of being termed a 'low pressure' field, Lakes Entrance might more properly be called a low permeability field. From these observations it is indicated that there is a possibility that the hydrostatic head existing below the oil sand can be turned to advantage in proper operation of horizontal wells into a natural water drive, to flush the oil into the wells."

The summarized information in the Ranney-Fairbank report furnished to the Commonwealth Government is that the oil content of these sands at Lakes Entrance is approximately 400 barrels per acre foot, or 11,600 barrels per acre; a 25 per cent recovery at least is expected.

Messrs. Avery and Anderson, in a review of information gained from Victorian Mines Department reports, show that 1 per cent by weight oil content of the glauconite would provide 4·55 gallons per cubic yard.

The summarized position is that recent carefully checked information has enabled a better knowledge and application of the field to be gained, Sir Edmund Teale's views, appearing in the same issue of NATURE (p. 31) being strongly supported by these later investigations.

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WHILE it is gratifying to learn these results, even so, the fact that we are dealing with an oil-water fluid and a rise of only 5 ft. per day does not indicate to me, at all events, that this is a normal crude oil or that there is a substantial hydrostatic head below it in the "glauconite" (oil horizon). Without all the current facts it is difficult to assess the real position in this field, but at least it is to be hoped that, whether developed by standard methods or otherwise, some good use may be made of what oil is ultimately won, even if no petrol or light distillates can be refined from it.

H. B. MILNER.

RESEARCH ITEMS

India's Population

IN a paper entitled "Half a Century of Population Trends in India", in the *Geographical Journal* of Nov.–Dec., 1941, A. Geddes has worked out the population density of the administrative districts of India from the censuses of 1881 and 1931 and has plotted for each district not only the percentage change (increase or decrease) but also the variability or deviation from any steady rate of change. This entailed an examination of the figures of the intervening censuses. This method brings out many important considerations. Thus in Bengal the east shows high increase, with very low variability, in contrast to the west, which shows arrest without variability, or a state of stagnation. Rice lands of the south showed slight variability whether there was arrest, as in the Cauvery delta, or high increase, as in the deltas of the Kistna and Godavari. Broadly speaking, arrest or stagnation seems to be the outcome of deficiency of necessities and endemic diseases, while strong fluctuations about the mean, which might be accepted merely as arrest, are characteristic of the famine tracts. This is not a condition of stability, though, as Geddes points out, a careless reference to census figures might suggest that conclusion.

Influenza A Virus

Leslie A. Chambers and Werner Henle, of the Department of Pediatrics and the Johnson Foundation for Medical Physics, University of Pennsylvania, described work on influenza *A* virus before the American Philosophical Society on November 22. The infectious agent of influenza *A*, as it occurs in emulsions of infected mouse lung, is associated with particles about 100 mμ in diameter. Particles of similar size, chemical composition, density, staining properties and electron-microscopic appearance are derivable from normal lung tissue. Virus contained in the extra-embryonic fluids of infected chick embryos is not associated with such large structures, but may be absorbed completely from such fluids by the particles derived from normal lung tissue. This, together with other evidence, indicates that a component of normal cells may act as carrier of a considerably smaller pathogenic agent. Concentration of the virus from extra-embryonic fluids was accomplished by precipitation with protamine. Analysis of the resulting infectious complex indicates that the virus consists largely, if not entirely, of nucleoprotein. Ultra-centrifugation at about 90,000 gm. for 9 minutes sedimented almost all the infective material from egg fluids. Sedimentation diagrams of the resuspended sediment showed two components to be present. One of these gave a well-defined boundary and had a sedimentation constant of 31×10^{-13}, corresponding with a particle size of about 12–14 mμ and a molecular weight of about 1,000,000. Fractionation by ultra-centrifugation, followed by protein analysis and infectivity tests, indicated that the heavier, less homogeneous component (S_{20} = about $800 \pm 100 \times 10^{-13}$) consisted, almost entirely, of aggregates of the smaller units. The two sedimentable fractions were infectious in approximately equal dilutions. A minimal infectious dose contained about 10^{-16} gm. and therefore consisted of less than a hundred particles. A size distribution curve based on measurement of electronmicrographs of the isolated virus protein showed the particles to be essentially spherical and to have a modal diameter of about 11 mμ. This is in good agreement with the estimate based on the sedimentation constant, $S_{20} = 31 \times 10^{-13}$. In view of this evidence, the virus of influenza *A* is regarded as one of the smallest pathogenic agents yet isolated.

Parthenogenetic Activation of Rabbit Eggs

HERBERT SHAPIRO, of Hahnemann Medical College, Philadelphia, described the parthenogenetic activation of rabbit eggs in the unoperated animal at a meeting of the American Philosophical Society on November 22. It has been shown in earlier work that cold is an effective agent in initiating artificial parthenogenesis in rabbit ova *in vitro*. By inducing rabbits to ovulate as the result of a course of pituitary extract injections, tubal eggs of known age could be cooled *in situ* in the anæsthetized animal, under sterile surgical conditions, by circulating cold water through a metal jacket into which the tube was inserted. This mode of treatment did in one instance lead to the birth of a normal parthenogenetic female, capable of normal reproduction. In the present series of experiments, rabbit eggs were activated parthenogenetically in the intact animal, without operating surgically. Rabbits were made to ovulate as usual by pituitary injections. Cooling of the entire animal was effected by applying an ice pack on the doe's flank, directly over the region of the Fallopian tube, as she lay anæsthetized on the table. Rectal temperature, respiration and pulse-rate were recorded at regular intervals. The uterine tube, which lies just under the abdominal musculature, was very likely brought to a temperature lower than that indicated by the rectal thermometer. Body temperature (normally about 39·7° C. in the rabbit) was lowered to points varying from 33·6° C. to 18·0° C. In all experiments, perfect recovery of the animals occurred. Eggs were secured at various intervals after the experiment by flushing the Fallopian tube, and they were then fixed and sectioned for microscopic study. Artificial parthenogenetic activation was obtained in two animals, one of which contained two eggs in the two-cell stage, when examined forty hours after the activating treatment, and another contained a young embryo in the early morula stage. More advanced stages in embryogenesis have not thus far been obtained.

Leaf-Curl Virus Diseases

THREE leaf-curl diseases of plants in South Africa have been described by A. P. D. McClean (*Sci. Bull.*, No. 225, Dept. of Agr. and Forestry, Union of South Africa. Govt. Printer, Pretoria. Pp. 66; 6*d*. 1940). Leaf-curl virus of tobacco causes a yellow network on the leaves, followed by projection of the smaller veins, and finally the formation of leaf-like enations, with malformation of the foliage. It has been transmitted by White fly to a considerable range of Solanaceous hosts, and does not appear to be transmitted by mechanical means. Separate leaf-curl diseases have also been described on petunia and hollyhock. The former virus has been transmitted by grafting to tobacco, *Nicotiana glutinosa*, and tomato. It forms enations but no chlorotic pattern upon tobacco, and induces petal-like outgrowths from the corolla of petunia. Leaf-curl of the hollyhock induces chlorosis and emergent veins, but no enations.

Detection of Lactose and Maltose by means of Methylamine

W. R. Fearon described before the Society of Public Analysts and Other Analytical Chemists on February 4 a simple test based on the observation that when alkaline solutions of lactose or maltose are heated with methylamine hydrochloride under prescribed conditions a bright violet-carmine colour develops. The test shows concentrations of the sugars down to 0·05 per cent. The carmine colour is not given by other carbohydrates or related compounds tested, or by proteins, fats or biological secretions, such as saliva or urine. Other reducing sugars may be coloured yellow by the hot alkali, and in excess they may interfere more or less with the test by combining with the amine.

Decomposition of Carbonic Acid

The evolution of carbon dioxide from bicarbonate by mixture with acid is usually supposed to go in two stages, a practically instantaneous ionic reaction $H^{\cdot} + HCO_3' = H_2CO_3$, followed by a unimolecular time reaction $H_2CO_3 = H_2O + CO_2$. By using a calorimetric method in which the two solutions undergoing reaction are driven into a mixing chamber and thence into an observation tube in which the temperature is measured at several points, F. J. W. Roughton (*J. Amer. Chem. Soc.*, 63, 2930; 1941) has shown that these two stages actually occur. The separate heats of reaction were determined over a range of temperatures and also the velocity constant of the second reaction. The values of the equilibrium constant, $[CO_2]/[H_2CO_3] = 950$ at 0°, and of the first true ionization constant, $a_{H}a_{HCO_3}/[H_2CO_3] = 2\cdot5 \times 10^{-4}$ at 0°, were also calculated. The heat of the ionic reaction was found to vary with temperature in a manner characteristic of weak acids.

Atomic Weights of Silver, Bromine and Potassium

In a study of the thermal decomposition of potassium bromate, with a precise correction for the moisture content of the salt, and the comparison of pure potassium bromide with silver by precipitation as silver bromide, R. K. McAlpine and E. J. Bird (*J. Amer. Chem. Soc.*, 63, 2960; 1941) have obtained new values for the molecular weight of potassium bromide and the atomic weight of silver; and from these, by application of the ratio of bromine to silver from the work of Baxter and Hönigschmid, values for the atomic weights of bromine and potassium referred to the new value for silver have been calculated. The atomic weight of silver found is 107·879, agreeing within 1 part in 100,000 with the present accepted value. The atomic weights of bromine and potassium calculated from this and the ratio Br : Ag = 0·740786 are 79·915 and 39·096, respectively. On the basis of the international value Ag = 107·880, the atomic weight of potassium would be 39·095. These figures provide an important check on the work of Hönigschmid and Sachtleben on the atomic weight of silver, in which the absence of moisture in the barium perchlorate and barium chloride used was proved only indirectly.

Lower Oxides of Boron

In 1916 Travers, Ray and Gupta showed that when the residue from the repeated extraction of crude magnesium boride with water was treated with concentrated ammonia in an atmosphere of hydrogen the solution contained a substance of the composition $H_{12}B_4O_6\,2NH_3$, and when the ammoniacal solution is evaporated to dryness in a vacuum and gently heated, an oxide B_4O_5 remained, together with a small quantity of magnesia. R. C. Ray and P. C. Sinha (*J. Chem. Soc.*, 742; 1941) find that when the residue obtained by repeated and prolonged treatment with water of crude magnesium boride is kept in contact with successive portions of a fairly concentrated solution of ammonia in an atmosphere of hydrogen, and the filtrate concentrated in vacuum at room temperature, crystals separate from which, by fractional crystallization, two compounds, $(NH_4)_2B_2(OH)_2$ and $(NH_4)_2B_4O_6$, are obtained. When heated in a vacuum these formed powders of the oxides B_2O_2 and B_4O_5, respectively: $(NH_4)_2B_2(OH)_2 = B_2O_2 + 2H_2 + 2NH_3$, and $(NH_4)_2B_4O_6 = B_4O_5 + H_2O + 2NH_3$. The oxide B_4O_5 is perfectly colourless but B_2O_2 is slightly brown. The oxides are readily soluble in water, forming colourless solutions.

Sedimentation of Washed Red Blood Cells

The gradual development of biophysics is evident in occasional papers in the physical journals. A recent example comes from the Engineering Department of the University of Manchester, where R. B. Whittington has studied the sedimentation of washed red blood-cells (*Phil. Mag.*, 33, 68; 1942). The experiments were made as a first step towards a mechanical investigation of the red-cell sedimentation test, the sedimentation of whole-blood suspensions being too complex for direct mechanical study in the initial stages of the work. Although the red blood-cells approximate to elastic biconcave disks of diameter six times their thickness, they cannot be treated as non-biological material of the same dimensions. The suspending solution must be isotonic with blood-plasma. If the cells were suspended in a solution containing excess of salt they would shrink owing to loss of fluid by osmosis. A deficiency of salt would lead to swelling if not to rupture. Varying speeds of motion could not therefore be obtained by merely altering the specific gravity of the fluid unless it could be kept isotonic. Instead, a sodium chloride solution, 0·85 per cent by weight, was used throughout and the 'effective viscosity' was altered by varying the proportion of suspended cells. The drag-coefficients plotted logarithmically against the Reynolds' numbers gave a straight line graph.

Excessive Expansion of Dental Amalgams

Dentists have frequently been puzzled by an excessive expansion of dental amalgams. The normal expansion or setting is about 8 microns per cm. After 10–20 hours no further expansion should occur. Some specimens have, however, been found to expand more than two hundred microns in thirty days. The mystery has been solved by J. C. Schoonover and associates (*J. Franklin Inst.*, 232, 579; 1941). Records show that the excessive expansions occur only with alloys containing zinc and only in the presence of salt solutions such as NaCl. Gas pockets were found in such expanding amalgams, and the gas has been identified as hydrogen. Non-zinc alloys do not show this abnormal expansion, nor do zinc-containing alloys if they are amalgamated in a clean mortar or a mechanical amalgamator and are not contaminated by handling. The problem arose from the accidental introduction of NaCl from the perspiration of the palms of the hands of dentists when handling the alloys in the course of normal dental operations.

SEAWEED AS A FOOD FOR LIVESTOCK

By J. BEHARRELL

FACTS and figures concerning the extent to which seaweed in the form of a dried meal is incorporated in balanced rations for cattle, sheep, pigs and poultry are surprising and confirm the value placed upon seaweeds by the people of the Far East. Those who have lived in China know the value placed upon seaweeds. The Chinese import the dried product from the Pacific coast and use it daily as an important part of their diet; it forms one of the chief sources of supply of mineral salts. In the Hawaiian Islands more than seventy species of seaweed are reputed to have food value, but so far as is known no one has yet attempted to classify the world's Algæ, or even those of any country, according to their edible qualities. These appear to vary widely as to plants and in the parts of individual plants.

Among the most recent analysis of dried seaweed meals are those made in June 1939 by Dr. Bernard Dyer and Partners of London, which show the following:

	Norwegian	Scottish
Moisture	13·58	15·50
Oil or fat	4·40	1·50
Albuminoids	6·90	10·90
Digestible carbohydrates	53·95	35·30
Fibre	5·07	9·30
Ash	16·10	27·50
Mineral Matter		
Phosphoric acid	0·46	0·83
Lime	2·15	3·51
Magnesia	0·17	0·38
Sodium chloride	2·70	6·73
Soda in other forms	1·64	
Potassium iodide	0·07*	0·65†
,, chloride		4·98
Potassium in other forms	1·98	3·98
Iron oxide	0·10	0·32
Silica	0·20	1·40
Carbon dioxide, sulphur trioxide, etc. ...	6·63	4·72
Carotene	6·2	0·3

(parts per million)

* Equivalent to 500 parts iodine per million.
† Equivalent to 5,000 parts iodine per million.

While the analysis quoted gives the amounts of the major elements present—a spectrographic examination of the same product by the Macauley Institute for Soil Research carried out in March 1940 reveals the presence of sodium, calcium, magnesium and potash, with small quantities of barium, strontium and lithium and a trace of rubidium. Other elements observed in the ash were titanium, aluminium, iron, manganese, silicon and a trace of copper. The non-metals are not easily determined by spectrographic analysis, but the report states that copious iodine fumes were observed on ashing.

The concentrate, with the alkalis and alkaline earths removed, showed the presence of the following—quoted as parts per million of the original seaweed meal:

Cobalt	0·2	Vanadium	1
Nickel	10	Molybdenum	1
Tin	1	Gallium	0·5
Lead	1	Chromium	1
Silver	0·5	Lanthanum	10
Zirconium	3	Gold	
Zinc	40	Thorium	
Copper	10	Scandium	

The other trace elements mentioned are present in amounts of 1–10 p.p.m. but it was not possible to determine the exact percentages as no suitable standards were available.

This spectrographic analysis indicates the potential value of this product of the sea as a food for livestock.

Evidence of the value of seaweed for farm stock recently came from New Zealand (*Weekly News*, July 16, 1941).

The Laplanders feed seaweed to their cattle and so do the inhabitants of the Faroe Islands. In the Orkneys the magnificent stock is fed on seaweed as a proportion of their ration. At Stronsay in the Orkney Islands Laminaria is used. This is first dried by sun and air, being spread out thinly and treated as quickly as possible after being taken from the sea, otherwise it tends to decompose and is then unfit for stock feeding. Collection is made at all times of the year, but it is found by analysis that the iodine and mineral value is highest in the late summer and autumn. According to certain authorities it is an advantage to wash the weed and so remove any surplus salt.

The method employed in the north of Scotland is to dry the weed, and more particularly the long slender stipes (which are richer in iodine) by sun and air for several days, then to slice the latter by means of a special cutter, followed by a grinding process to reduce it to a fine grist.

This is finished on a rotary dryer—at a temperature varying from 350° C. to 450° C. for a period of forty minutes—and is later ground in the usual Christy and Norris type of disintegrator, when it is ready in fine meal form for blending in various types of feeding stuffs or in concentrates. The percentage used in the compound food is small, the usual rate being 1 per cent of the total food (by weight), but this can be increased to 2 per cent or slightly more with perfectly good results. Stock fed with this addition to their ration have increased stamina and a stronger resistance to disease. In the United States the Overbrook Dairy Herd, receiving dried seaweed meal in their ration, won the World's (Herd) Record for milk production.

A comparison between oats and a meal produced from dried *Laminaria flexicaulis* gathered on the coast of Brittany was actually made in a communication to the French Academy of Sciences in 1918. It gave the following figures:

	Oats	Dried Laminaria meal
Water	12·55	14·40
Carbohydrate matter	66·80	52·90
Nitrogenous ,, ...	9·10	17·30
Cellulose	8·45	11·50
Mineral matter	3·10	3·90

Results of feeding experiments gave 3 lb. of the meal as being equal in feeding value to 4 lb. of oats.

As 8–9 tons of fresh seaweed are required to dry down to 1 ton of fine meal, one million tons of seaweed would therefore produce the equivalent of 150,000 tons of oats, together with 1,200 tons of fertilizing material rich in potash.

It has been stated that in the islands of the Orkneys alone 30,000 tons of seaweed are available each year, so that the total quantity available round our coastline must be millions of tons.

With the backing of scientific research and practical feeding tests a vast reserve might be created to the great gain of our farmers and our stock feeders.

Present-day methods of gathering and processing by mechanical power might be improved—manufacturing costs, per ton, reduced to an economic level. There is evidence now that seaweed would provide food for farm animals in the years after the War, and profitable by-products for industry.

A considerable business has been created on the Californian coast to exploit the enormous jungles of giant kelp (*Macrocystis pyrifera*) which grows in the Pacific up to lengths of 500 ft. A machine mounted on a barge shears off the tops to a depth of three feet, which is the maximum permitted by the Government. Taken ashore, the kelp is treated in a similar way to that used in Scotland—dried in steam-heated or hot-air cookers, and ground to a fine powder, which must pass through a twenty-mesh sieve. The product is known as kelp meal and is mixed with a proportion of fish meal and sold as a seameal concentrate. Apparently not more than one tenth of the kelp meal harvested on the Pacific coast is prepared for stock food; all the rest is used for the extraction of iodine and for sodium salts.

The urgent need is for carefully checked records of the sea vegetation available, of the chemical value as a feeding stuff, for detailed digestibility trials, for the quantities required by stock to secure maximum results, and of its effect upon the health of all farm stock—a wide programme but one that should ultimately bring to agriculture thousands of tons of valuable home-grown feeding stuffs, from the sea-bed.

FORESTRY IN MALAYA

ONE reads with intensified interest the report of the progress of forestry in Malaya, now, we may trust for but a brief period, put to an end by the irruption of the Japanese. J. G. Watson, the head of the Forestry Department (if we omit the local inter-divisions of forestry administration of but little interest to the outside world), has written the "Annual Report on Forest Administration in Malaya including Brunei for the year 1940" (F.M.S. Govt. Press, Kuala Lumpur; 1941). In the report for the preceding year his predecessor, very fortunately as may now be thought, gave a valuable and interesting history of the growth of the Department from the year 1883 (see also NATURE, 148, 312; 1941).

In a general review of the year Mr. Watson mentions some small additional reservations of forest (347 square miles), bringing the total area of Government forest reserves to 10,879 square miles or 20·4 per cent of the total area. The actual area covered with forest of one type or another in Malaya is almost 77 per cent, 56·6 per cent of forest land being still unaccounted for. It is the existence of this mass of tropical forest covering the region which enabled the Japanese to penetrate so easily through the country.

Some interesting sylvicultural work was being undertaken, an all-Malayan regeneration *coupe* having been laid down for the conversion of inland forest. This annual *coupe* has been tentatively fixed at 12,088 acres; 1,000,000 acres have been set aside for this intensive management, of which 34,458 acres had been fully regenerated. The director of forestry says of this scheme that it is not yet fully operative in the more backward States where State land resources are still large. Differentiation between hard-wood and soft-wood areas is not possible as yet, but preference is given to those rich in the former. Eventual control will have to be on the basis of volume rather than area so far as hard-woods are concerned. It is sad to think that a certain proportion of this work will probably be lost, smothered by a victorious jungle of weed growth now that the attention of the forester will temporarily be no longer available. For those with a knowledge of the processes of growth in the tropical jungle are well aware that regeneration work of this kind can only be successful if carefully watched and given full assistance during the early critical periods. Already this work was becoming more difficult owing to the reduction of the staff through members joining the fighting forces.

This latter strain was, however, perhaps even more heavily felt in connexion with the timber industry and the numerous saw-mills of which there were eighty at work in connexion with the forests; fifteen of these mills are in the Straits Settlements (Singapore and Penang), forty-five in the Federated Malay States (Perak, Selangor, Negri Sembalin, Pahang) and twenty in the Unfederated States (Johore, Kedah, Perlis, Kelantan, Trengganu, Brunei). The combined outturn of all mills outside the Straits Settlements was 123,183 tons of 50 cub. ft. as compared with an estimate of 98,580 tons from Penang and Singapore. Apparently these two latter also saw up logs coming from Sumatra.

War conditions threw a heavy strain on the timber industry, which was (and, says the report, "will continue to be") hard put to meet emergency orders without dislocation of normal undertakings. The total outturn of logs was nearly 3,000,000 higher than the preceding year, the sawn timber running roughly each year at the same figure of 4,900,000 cub. ft. The one ply-wood factory produced 20,000,000 sq. ft. of three-ply sheets, and the four match factories seventy-three million boxes of forty matches apiece. The revenue from the forests during 1940 was 2¼ million dollars.

In spite of the absence of a number of officers detached to war duty, a certain amount of research work was continued throughout the year under various heads. It may be hoped, however, that when the department once again starts work in its forests more attention may be paid to preparing some working plans, the absence of which, in so advanced a department in many respects, is a curious anomaly.

If the annual report of 1940 is likely to be the last to be printed until the Japanese are sent out of Malaya, what can be said for the present prospects of the *Malayan Forester*, the December 1941 number of which has just been received?

An article on "The Contribution of Tropical Forests to War Economy", by H. E. Desch, wood technologist in the Forest Research Station in Malaya, is not without interest. In fact, it stresses without being aware of the fact, some of the dangers of the war exploitation of tropical forests already mentioned in NATURE. "A country rich in forests", says the author, "is obviously under an obligation to ensure that full use is made of its forests in War." This is undeniable, but it is just that "full use" in the case of the tropical forest which requires to be definitely understood. Too often the forest, at the mercy of the fellings of the timber merchant without expert supervision, has been ruined. The surprising demands which modern war make upon the forest are exemplified in a paper, "Forest Products and Defence", by C. P. Winslow, director of the U.S. Forest Products

Laboratory. To house a division of approximately 17,000 men in barracks requires 2,000,000 cub. ft. of timber; rather more than half if the men are quartered in a tent camp. Battleships are said to require 40,000 cub. ft. of timber and ocean transports 60,000 with an additional 300,000 sq. ft. of ply-wood, and so forth. The output of local sawn-timber and ply-wood in Malaya in 1940 has been already mentioned. Mr. Desch considered that the forests would be drawn upon to produce much larger amounts than that, and yet the forest service had already been called upon to allow a proportion of its gazetted staff to join the Forces. This was the position and in the absence of a recognition of the part played by the tropical forest in the economy of a country it appears probable that war demands would have similarly upset the good work which an excellent staff have been inaugurating during the past twenty years.

Mr. Desch regards this matter from the research and utilization point of view. His argument appears to be that the tropical forests of Malaya should be regarded as a source of sawn-timber and other produce for industries already existing in the country; but that their products should not be utilized for setting up, that is, supplying, the raw produce for new industries which, while interfering with the settled economy of the country, would require possibly new imports for their maintenance.

In how far the author's ideas would receive acceptance from the practical forest officer is open to doubt. But his ideas and these doubts must now remain for a future consideration.

SEISMIC PERIODICITY

This subject has been discussed by Archie Blake, who states that classical methods for detecting and measuring periodicity have suffered from two serious defects[1]. First, the Schuster periodogram does not provide adequately for non-sinusoidal types of variation. Secondly, the smoothness encountered in almost all time series and many other types of data introduces a spurious appearance of periodicity which vitiates the test of significance unless proper allowance is made for the smoothness. New statistics designed to detect effects not contemplated in the Schuster periodogram are being tried in a study of the series of aftershocks of the Helena Montana earthquakes of October 1935. This work is being done by use of punched cards, which greatly alleviate the labour of the computation.

In the case of two types of departure from randomness, such as periodicity and smoothness, each effect disturbs the statistics designed to detect the other. The only rigorous treatment is to study them together, but approximate methods (for example, that of Bartels) for discounting the effect of one type of variation in studying the statistics designed to detect the other may be very useful. Thus the accurate detection of periodicity demands a treatment of the problem of detecting, describing and measuring the smoothness exhibited by the series under test. This problem has been discussed by Bartels, Jeffreys and others, and from a different point of view by Shewhart.

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[1] Progress Report on Periodicity and Time Series, by Archie Blake, Transactions of 1941 of the American Geophysical Union.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Friday, March 13—Saturday, March 14

British Association for the Advancement of Science (Division for the Social and International Relations of Science) (at the Royal Institution, Albemarle Street, London, W.1).—Conference on "European Agriculture: Scientific Problems in Post-War Reconstruction".

Friday, March 13

10.15 a.m.—"Measures for Reconstruction". (Chairman: Sir John Russell, F.R.S.)

2.15 p.m.—"Economic and Kindred Problems". (Chairman: Mr. F. L. McDougall.)

Saturday, March 14

10.15 a.m.—"The Future Betterment of European Farming". (Chairman: Dr. A. J. Drexel Biddle.)

2.15 p.m.—(Chairman: Sir John Russell, F.R.S.)

Monday, March 16

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. H. P. Rooksby: "X-Ray Technique in the Industrial Laboratory" (Cantor Lecture, 1).

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Colonel Orde Wingate: "Geography of the Ethiopian Campaign".

Tuesday, March 17

Royal Society of Arts (Dominions and Colonies Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Ernest Marsden: "Recent Developments in the Scientific and Industrial Research Programme of New Zealand".

Chadwick Public Lecture (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Dr. William A. Brend: "Nervous Shock in Peace and War".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Metals", 3: "Magnetic Properties of Metals".*

Royal Statistical Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. R. G. Glenday: "Economic Reconstruction after the War".

Wednesday, March 18

Oil and Colour Chemists' Association (Manchester Section) (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Dr. J. G. Gillan: "Some Aspects of Camouflage".

Institute of Physics (Joint Meeting of the London and Home Counties' Branch and the London and South-Eastern Counties' Section of the Institute of Chemistry) (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Prof. H. Levy: "Social Implications of Science in War-Time".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 4.30 p.m.—Dr. H. Spencer Jones, F.R.S.: "The Atmosphere of the Planets" (Symons Memorial Lecture).

Thursday, March 19

Institute of Fuel (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 2.30 p.m.—Dr. Ezer Griffiths, F.R.S., Dr. R. W. Powell, and Mr. M. J. Hickman: "Thermal Conductivity of Some Industrial Materials".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 6 p.m.—Dr. A. P. M. Fleming: "A Critical Review of Education and Training for Engineers".

Friday, March 20

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 4.30 p.m.—Sir Edward Appleton, F.R.S.: "Ionospheric Influences on Geomagnetism" (26th Guthrie Lecture).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (man or woman) in Pharmaceutical Subjects in the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth (March 18).

Technical and Constructional Assistant in the Borough of Luton Electricity Undertaking—The General Manager and Chief Engineer, Electricity Offices, St. Mary's Road, Luton (March 20).

Lecturer in Engineering Subjects in the Cardiff Technical College—The Director of Education, City Hall, Cardiff (March 25).

Assistant Drainage Officer to the Lancashire War Agricultural Committee—The Executive Officer, Institute of Agriculture, Hutton Preston (March 28).

Colloid Chemist or Physicist—The Director of Research, British Pottery Research Association, Queens Road, Penkhull, Stoke-on Trent.

University College of Science
PHYSICS Dept.
92, Upper Circular Rd, Calcutta.

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A SCIENTIFIC FOOD POLICY

WAR had brought famine to two of its first victims, China and Spain, before Great Britain took part in it. With the deliberate spoliation by the Nazis, the blockade and the scorched earth policy in the most fertile regions of the U.S.S.R., famine at the end of this War will be far worse than in 1918 and the following years. Some form of international famine relief commission must, perforce, be set up. It may be content to restore the unsatisfactory normal of the years before the War, or it may grow into a permanent organization that will attempt to raise the nutrition of people throughout the world to a satisfactory level—an organization that will differ from the wistful and ineffective League of Nations in having executive powers. If the present determination to make a safer and saner world survives the War, this relief organization will not give up the more ambitious aim.

Of the four freedoms of President Roosevelt, freedom from want, in respect of food at any rate, stands in a class by itself. Such phrases as freedom of speech may have very different meanings in New York and Moscow, in London and in Berlin ; even those to whom the words carry the same meaning, may differ in their estimates of the amount of freedom that should be allowed. But a calorie is a calorie all the world over ; the experts of nine States have agreed on the minimum amounts of various food constituents that freedom from want implies. The requirements are settled. How can the supplies be obtained and how can a fair distribution be ensured ?

We can take it that plans for the reorganization of British agriculture that suited the years before the War will no longer meet our needs. The economic position of Great Britain will have changed fundamentally ; we shall no longer be able to draw food and feeding-stuffs, as tribute, from half the world. Further, as Dr. Platt said at the recent meeting of the Nutrition Society (see p. 318), continued importation of large amounts of feeding-stuffs by Great Britain does not involve a competition for food between different kinds of domestic animals only, or even between men and animals only, but also between men and men ; the food for our animals is taken at the expense of men in other parts of the world. There are huge blocks of human life, in India and China, for example, whose standard of diet is not of the same order as the minimum proposed by the Technical Commission of the League of Nations or as the standard of diet of western Europe. Europe, excluding the U.S.S.R., with a population little more than one third that of Asia, consumes more cereals and six times as much meat. A world of such gross inequalities cannot be stable.

Physiologists have been impressed by the production (over a limited area and for a limited period) of supplies of food in excess of effective demand, and by the deliberate destruction and limitation of productive resources. They have been inclined to believe that there is no physical bar to the satisfaction of their demand for adequate food for all ; that ample is available to order. There is an opposite view; in its extreme form it is that human nutrition is a by-product of a cycle—fodder crops, animals, manure—that maintains the fertility of the soil. The exhaustion of the soil, which has reduced fertile land from Saskatchewan to Texas to whirling dust, has made us all realize that the soil cannot supply food in unlimited amounts and kind; that it is essential to plan the type of food produced so that the quality of the soil will be maintained. If this is not done in the traditional way with animal manure, some other way must be found.

Actually the world, as a whole, has never produced too many calories for human food; certainly, in the years after this War there will be no excess. It will be necessary to take care of the calories. Now, the largest number of calories for human consumption can be obtained from a given area if crops are grown that can be eaten by human beings. If feeding-stuffs are grown and used to feed animals, the return, in terms of calories, is poor. For example, an acre under potatoes will produce some four million (large or kilo-) calories for human consumption, and some two million if under wheat; but only one fifth of a million calories if used as grass-land for feeding beef cattle, and two thirds of a million if used to feed milch cows. Animals, like human beings, use up the greater part of their food to supply their daily needs of energy, and store only a small surplus as flesh; owing to the rapid growth of animals, the return is higher than might have been expected. But, during periods when calories are short, no more animals should be kept than are needed to maintain the fertility of the soil (supposing that no substitute is found) and to meet the special needs of human beings that are not well supplied by vegetables. The conversion factors give a fairly correct estimate of the relation between the amount of energy, for human beings, obtained if crops are used direct as human food and the amounts obtained if the crops are used indirectly for feeding animals which are eaten by human beings; for a calorie is much the same, whether obtained from animal or vegetable food.

But estimates of the amounts of protein produced by animals from a given amount of protein in feeding-stuffs cannot be used without qualification; they do not take into account the difficult question of biological value. Meat is of special importance in nutrition because animals pick out the indispensable amino-acids, which we cannot make ourselves from their food, and concentrate them in their flesh. The concept of biological value is unsatisfactory. It appears that wheat protein mixed with a small amount of animal protein may have the same value as an equal weight of animal protein. We cannot calculate the proportion of vegetable food to meat that will give the highest nutritive value per acre until we have a more exact knowledge of the metabolism of amino-acids and of their interplay. However, milk is in a class by itself; milch cows give a fairly high return, even of calories; the protein of milk has a high biological value; cows concentrate calcium and riboflavin in their milk; they return the carotene of their food mainly as pre-formed vitamin A, which is better absorbed by human beings. Taken all round, milch cows are by far the most efficient converters of vegetable feeding-stuffs into valuable food for human consumption. In times of shortage they are the only animals that should be allowed to compete with human beings for food; other animals, male calves, for example, should be killed young.

This concentration on vegetable crops, for direct human consumption, and on milk and milk products, gives the diet recommended by Sir John Orr both for war-time and during the reorganization of the world's food supply. So far as our present knowledge goes, it will supply everything that is needed.

At the end of the meeting of the Nutrition Society on February 28, Sir Joseph Barcroft stressed the importance of the flavour and interest of food. But there is no reason why milk products and vegetables should be flavourless or dull. There is a wonderful choice of cheeses, and no two Cheddars even taste quite the same. There is no need to cling to the narrow range of badly cooked vegetables that is traditional in Great Britain. What is wanted is better methods of transporting and storing vegetables, something comparable with the improvement in methods of storing fruit. As it is, however, the diets of many people are so dull that they must enliven them with crude flavourings. The Indian corrodes his stomach with curry and the Englishman spoils his palate and ruins his digestion with pickles and spices. The first edition of 'Blitz' soup, prepared to suit the taste of Londoners, was so fiery that it might have been used externally as a counter-irritant. Further, tastes are changing. British soldiers patronized milk bars, so long as they supplied milk. Experiments on children have been extended to adults eating in canteens; one can now see sturdy draymen sampling Oslo meals.

Vegetables and milk are best produced on the spot, whereas cereals are well suited for transport. The most effective policy would be one similar to the breadstuffs policy of the War of 1914–18. Peoples, such as those of India and China, who now wring just enough or not enough calories from the soil, might be supplied with cereals from areas such as Canada and the Argentine that can expand production and produce a surplus over their requirements. In this way, land in the over-populated countries could be set free for growing other crops and for feeding animals, with benefit to the health of the people and the fertility of the soil.

If the amount and quality of food is to be raised, agricultural machinery must be supplied. This will involve an increased demand on manufacturers, who will have to meet other demands to supply pressing needs—machinery for transport and building, for example. The Nutrition Society is a valuable meeting-place, in which physiologists can discuss with agriculturists how best their demands can be met. Should there not be a means devised of enabling agriculturists to meet manufacturers, state their requirements and learn the difficulties that may lie in the way of their fulfilment?

There are political difficulties, too. Small farms cannot use agricultural machinery economically. There must be some form of amalgamation, whether in State farms, collective farms, co-operatives or large groups of family units under one management. In China some 40 per cent of farms are less than 1⅔ acres; in Japan two thirds are less than 2½ acres. These little plots cannot produce proper food for the farmers' families. Some means must be found by which the density of the agricultural population can be reduced.

The production of sufficient food is only half the battle. The producer must know that his crops will find a market; the consumer must be able to buy the food produced. The whole reorganization must involve fundamental changes of custom and conflict with vested interests. Opposition may be less than it would have been a few years ago. All the world over, people are becoming familiar with food control; in Great Britain they are beginning to realize its possibilities. Also hunger is a strong argument, and hunger is one of the few things of which there is prospect of plenty at the end of the War. An International Famine Relief Commission will wield a convincing weapon—food; if it uses this weapon justly and efficiently it can do much to reconcile people to profound changes. Difficulties are great; they must be studied now. For only those who know clearly what they want and how to get it are likely to achieve anything worth having in the welter of conflicting policies at the end of the War.

INTERNATIONAL ECONOMIC EQUILIBRIUM

THE meetings of the Inter-Allied Council render one signal service in respect of reconstruction—they stress its international aspect. This has to some extent been overlooked in the studies and discussions on reconstruction which have so far been initiated in Great Britain, and for all the attention that has been given to the work of the Leith-Ross Committee and the establishment of the Leith-Ross Bureau to deal with problems involved in the storage of surplus foodstuffs and their distribution after the War to the peoples in enemy-occupied Europe, the economic aims stated in the fourth and fifth points of the Atlantic Charter have not received much emphasis. The political, economic and social aspects of international reconstruction cannot indeed be entirely separated. They are as interlocked as the international and the national or internal aspects of reconstruction, and our hopes of a new and stable world order depend largely on our exploring the situation now so as to lay bare the principles for a constructive policy in readiness for the time of action.

Much of that action must of necessity be deferred until after the War, though in certain matters preliminary action as well as the determination of broad lines of policy are already required. Demobilization, for example, clearly must receive consideration before the fighting ceases. Plans must be in readiness, and the experience of 1918 is with us as a warning that a sudden and unexpected collapse of the enemy should not again find us unprepared. Unpreparedness can as assuredly endanger the winning of the peace as it has hindered the organization of victory.

In the last year or so, the discussions which for the first year of the War were so prominent on Federal Union and the exact form of the organization of a collective security system have rather fallen into the background. It has been recognized that the final form of organization to be adopted is a question to be determined later. On the other hand, there is a wider recognition that forms of co-operation established to serve the common purpose during the War can equally contribute to the final purpose of winning the peace. Even before the United States entered the War, there was unmistakable evidence on both sides of the Atlantic of Anglo-American determination to maintain that co-operation, and the machinery now established will not be recklessly scrapped unless it is proved to be no longer serviceable.

Besides this, attention is being concentrated, not first on the machinery to be established, but rather on the problems to be solved, with the object of elucidating first principles and from them arriving at the methods and organization most likely to provide a solution. In the field of international reconstruction there is, for example, the problem of the relation of Great Britain to Europe. There is the problem of the place of Germany in a new European system. There are the questions of the colonial peoples and of raw materials, and there is the problem of reconstructing world trade.

All these problems are, of course, related and have at least some bearing on the organization of post-war relief in occupied Europe, as well as on the establishment of a new system of collective defence. None the less, they can each serve as the starting-point for an attempt to arrive at first principles and to remove some of the causes of international friction which contributed to the outbreak of the present struggle. This is admirably illustrated in the survey of international economic relations which Prof. J. B. Condliffe has written under the title "The Reconstruction of World Trade"*.

Prof. Condliffe's volume falls naturally into three parts. The first analyses the collapse of the international trading system that was restored, on the pre-war model, after the War of 1914–18. The second, including much the most technical chapters, examines the challenge now presented by the totalitarian methods of bilateral trade. The third surveys the problems that must be faced in any attempt to reconstruct world trade after the War comes to an end. The book is based largely on material drawn from research studies undertaken in preparation for a conference called to meet at Bergen on August 27, 1939, and much of it would normally have formed a report of the International Studies Conference on "Economic Policies in Relation to World Peace". It has, however, lost nothing of its pertinence in the interval, and this lucid exposition could scarcely be bettered as a guide to the discussion of trade policy after the War to which Mr. J. G. Winant and Mr. Sumner Welles have recently made such pointed reference.

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* The Reconstruction of World Trade: a Survey of Internationa Economic Relations. By Prof. J. B. Condliffe. (Prometheus Library.) Pp. 427. (London: George Allen and Unwin, Ltd., 1941.) 12*s*. 6*d*. net.

On the making of policy Prof. Condliffe writes forcefully in his opening chapter. He points out that a Government can rarely lay down in advance, and adhere to, a line of policy which is the result of mature judgment and reflection. Wherever action must be adjusted to an ever-changing set of circumstances largely beyond the control of any individual, group, or government, policy must be in large degree improvised and pragmatic.' Moreover, a discussion of the forces that shape national economic policies in the international field cannot be narrowly confined to the field of commercial policy. Prof. Condliffe refers pointedly to the effect of private enterprise, and it follows from what he says that any serious attempt to achieve a balance between freedom and order in the national sphere, as has been suggested by Mr. Geoffrey Crowther, is bound to determine largely the nature of economic policy in the international field.

A further important factor is the passing of power in recent years from the legislative to the administrative side of government. This is widely recognized, but its bearing on economic policy has scarcely been examined, and the searching questions which Prof. Condliffe raises demand careful answer if our reconstruction of world trade is to proceed on sound lines. He stresses the real danger of the progressive withdrawal of day-to-day policy from detailed public scrutiny and criticism. The concentration of power exercised for long periods without the check of public criticism makes individual errors more serious, because errors of policy tend to become cumulative. Moreover, administrative control of policy-making puts a premium upon organized pressure from directly interested individuals or groups of individuals, and lessens the consideration likely to be given to the general public interest, and particularly the unorganized interest of the consumer.

These warnings cannot be lightly disregarded in respect of whatever new measures of commodity control may be developed even for the relief of occupied European countries. The conflict between national regulation and international equilibrium must be recognized, and while we may seek, as Prof. Staley has urged in "World Economy in Transition", to lessen the economic significance of national boundaries, the task of creating effective organs of international co-operation on a regulated basis must not be shirked. Meanwhile Prof. Condliffe's conclusion that the best practical prospect of restoring international equilibrium lies in the re-establishment of known and accepted routine lines of policy, based upon a relatively moderate degree of national planning in the sense of assuring to each national community reasonable minima of security and livelihood, is at least in keeping with the terms of the Atlantic Charter. World economic activity, like world peace, is in fact indivisible.

The relation of freedom of trade to the establishment of social security in the field of nutrition has already been emphasized in such studies as F. L. McDougall's "Food and Welfare", and Prof. Condliffe's book shows how closely it is related to the wider aspects of security. Government policy, not economic or scientific developments, has been responsible for the great decrease in trade in agricultural products, both food and raw materials. The primary responsibility for the breakdown in international trade lies not with economic facts but with economic policy, arising from attempts to place the interest of particular groups before that of the community as a whole and, in particular, to preserve and buttress the unfettered sovereignty of the national State.

International economic equilibrium is not a static but a dynamic concept, and we have yet to develop the appropriate organization and technique now that the technical progress of industry has outgrown national boundaries, as in an earlier age it outgrew the boundaries of city States. Social regression, not security, will follow from any attempt after the War to cling to traditional forms of political organization and put back the clock of scientific knowledge and industrial technique. The dangers inherent in modern tariffs and the complications of tariff bargaining, the administrative obstacles they introduce to trade and the extent to which they represent a reversion to tyrannical methods of government are unmistakable in this analysis. Bilateral treaties negotiated in recent years represent, on the whole, grave restrictions on multilateral trade, and the warm tribute which Prof. Condliffe pays to Mr. Cordell Hull's efforts to promote multilateral trade and breach the high protective wall erected by the Howley-Smart tariff does not disguise the little that had been achieved in removing the obstacles to the restoration of world trade.

It must be recognized therefore that while attempts to preserve past privileges of occupation or ownership may wreck international co-operation in the future as they have done in the past, the absence of any real will-power has been the decisive factor. Policies of independent economic nationalism can never form the basis of co-operation. Their ultimate aim is world domination and their technique is that of conflict. No compromise is possible, in the long run, between States that are organized to serve the purposes of individual citizens and those in which the individual is subordinated to the service of the State.

Prof. Condliffe's thoughtful chapter on new aspects of international organization well illustrates the need for further investigation if we are to formulate a sound policy for the reconstruction of world trade. We have to take account, not merely of the limitation or redefinition of national sovereignty, but also of the tendency of business organization and trading relations to become international in scope. The importance of the borderland between business and government with regard to international relations has increased considerably and still presents one of the most significant fields for economic research. Moreover, experience gained with certain of the war-time controls can scarcely fail to prove invaluable for the correction of the weaknesses revealed in some of the pre-war international commodity control schemes and to increase our exact knowledge of their extent and relations with government regulation. If Prof.

Condliffe does not visualize anything like the Raw Materials Union suggested by "Balbus" in "Reconstruction and World Peace" (Democratic Order Pamphlet No. 10) and in the P E P broadsheet, "Commodity Control Schemes", he at least sees the possibility of dealing with the consumer interests more fairly and effectively.

The extension or development of international commodity schemes is a difficult problem. There is no very satisfactory half-way house between a free trading system based on *laisser-faire* and one in which national production is co-ordinated in a system of international planning. Moreover, Prof. Condliffe has misgivings about the international planning of policy, for reasons already indicated, and while he considers there are wide areas of economic activity over which government control could with advantage be extended, such control should be limited to regulation rather than operation, and for this new types of international political and economic institutions must be invented. Indeed, the possibilities of international economic co-operation in the immediate future will largely depend on the way in which governments use such powerful new instruments as credit regulation.

While the necessities and disillusions which follow a great war may be powerful factors of constructive co-operation, that only holds if they are used in that direction. Peace is a dynamic process, the other name for which is co-operation, and only a world which is prepared to make the continuous effort of re-creating peace, like freedom, year by year, can establish and maintain a new international system of economic co-operation and social security. The most hopeful feature of that Anglo-American co-operation which has developed during the last fifteen months has been the frank indication on both sides of the intention to see it to completion.

Prof. Condliffe recognizes the paramount influence of the United States on any international system vhich can be established, and that it must be based n Anglo-American co-operation. He touches on ose other problems of the position of Britain in rope which also affect the ultimate solution, and esses that the choice before us is broadly one tween entering a European confederation or joing with the United States in an effort to re-establish a world trading system. But it is less for the outline of a suggested solution of the problem than for its clear analysis of principles, its firm warnings of the angers that cumber the way, its challenge to search- g inquiry and constructive thought that Prof. ndliffe's book is an outstanding contribution to discussions which Mr. Winant, Mr. Cordell Hull, Sumner Welles and others have already initiated. he guarded language which Lord Cranborne essarily used in November in replying to a question the House of Lords regarding the methods by which e Government proposes to give effect to Article V the Atlantic Charter and to secure the fullest llaboration between all nations in the economic d should not be taken as indicating that the vernment is not alive to the importance of this ject and anxious to secure the improved labour standards, economic advancement and social security implied therein. Practical plans of economic co-operation already engage its attention, and the growing ties between the two great democracies should ensure that they will face together now, and not merely after the War, the broad changes of policy involved in the inevitable internal and external reconstruction. Moreover, in approaching and studying these problems it must be remembered that by the adhesion of the Soviet Union and of the Allied Governments now in London, the Atlantic Charter has become a multilateral pact. The co-operation of twenty-six nations in fighting aggression is already pledged thereby to continue after victory is won to ensure that the world shall gather its fruits in peace and in security.

The immediate task in regard to world trade is of course to create the international machinery for co-operation after the War to enable people to live, to find the means of livelihood, and to exchange their products with one another, and to arrive at common understanding as to the principles on which such machinery shall operate in the conditions likely to obtain at the end of the War. The impartial examination of practical problems in a new setting, without regard to theories or dogmas framed to meet other conditions, should be able to evolve plans for preventing a repetition of the chaos which followed 1918. The four freedoms will only be established by planning and co-operation and an immense amount of hard work, in which the reconstruction of world trade is one of the first steps to the establishment of that freedom from want, which in Mr. Winant's view should be one of our first objectives after the War. There should be no lack of response in Great Britain to the efforts already being made in the United States in the study of these problems, so as to extend the present co-operation after the War into the organization of the exchange of goods on co-operative instead of on narrowly competitive lines.

WEATHER ANALYSIS AND FORECASTING

Weather Analysis and Forecasting

A Textbook on Synoptic Meteorology. By Prof. Sverre Petterssen. Pp. xvi+505. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 35*s*.

FOR twenty years the Norwegian school of meteorology has led the world in the development of methods of forecasting. The appearance of a treatise on weather analysis and forecasting by a distinguished member of the school is therefore an important event. Prof. Sverre Petterssen was for many years on the staff of the Geophysical Institute at Bergen and recently succeeded Prof. C. G. Rossby as professor of meteorology at the Massachusetts Institute of Technology. His book developed from courses of lectures delivered during the years 1935–40 at various places in America and Norway.

Long before the influence of the Norwegian school was felt, meteorologists realized that the weather was influenced largely by the interplay of currents of air from different parts of the globe. Occasionally, when contrasts of temperature were great, boundaries were drawn on a series of maps and the progress of such boundaries, which were frequently marked by line-squalls, was traced from map to map. The new school introduced the practice of drawing these boundaries or ‘fronts’ between different ‘air masses’ on every working chart. It was soon manifest that the charts gave much more vivid pictures of the weather over large areas than had ever been obtained before. A striking development was the recognition of the fact that the isobars, when carefully drawn, are kinked where they cross fronts. When once the eye is trained to look for these kinks, one wonders how the meteorologists of yesterday could have drawn smooth isobars through the areas where the wind distribution cried out for sharp bends. Modern forecasting depends largely on the study of the movements of fronts.

In the rules for forecasting developed by Petterssen, great stress is laid on arithmetical calculation. He is not content to notice that a front or any other feature of the weather map is moving towards the east. He works out the speed at which the feature has been moving and finds that, if all goes well, the feature will have travelled so far in the next twenty-four hours. The rules which are propounded are simple enough. They could have been introduced as soon as the practice of reporting the barometric tendency (the change of pressure in three hours) was initiated in the weather reports from telegraphic stations. The general rule is that any well-marked feature of the weather map will probably continue for several hours to move as it has been moving. The rule is reduced in each case to an appropriate numerical formula, which justifies the author’s bold quotation, on the flyleaf facing his title-page, of Lord Kelvin’s dictum :

“When you can measure what you are speaking about and express it in numbers, you know something about it ; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre, unsatisfactory kind.”

In the main, the processes developed by Petterssen are purely kinematical, the map is regarded merely as the representation of a moving, changing pattern, but use is made of the idea of the gradient wind in four of the thirty-one rules that are set out.

The individual forecasts which are quoted are remarkably accurate. While the forecasts of the movements of systems are purely kinematic, depending solely on the first law of motion, the deductions as to the resulting weather are made with an intimate appreciation of the effects of the varying structure of air masses with different histories.

It might have been expected that the upper air observations available to the forecaster would have been brought into these numerical forecasts. Actually, in Petterssen’s own scheme the information available serves rather to give the structure of the atmosphere in the several air masses and in defining the positions of the fronts. However, that is not the end of the matter. It is an important question to the forecaster this, how to make the best use of the upper air observations which are obtained by special aeroplane ascents and, in the most modern technique, by radio soundings. The system adopted in the United States, where such observations are now well distributed, is to map temperature and humidity corresponding with an isentropic surface, that is, a surface on which the potential temperature of air (the temperature to which it would be brought by adiabatic compression to the standard pressure 1000 mb.) has a constant value, such as 26° C. This way of representing the conditions in the upper air was first suggested by Sir Napier Shaw. It has the advantage that a single set of lines represents the distribution of temperature, pressure and density. Further, so long as the air is not affected appreciably by radiation, conduction and turbulence, it must move on an isentropic surface. Rossby, who developed the practice of using isentropic charts, found it useful to show humidity by the proportion of water vapour in the air. The way in which the vapour is conveyed from region to region across the continent is portrayed most vividly. The valuable chapter on this subject is contributed to the book under notice by Mr. James Namias, who was Rossby’s collaborator at the Massachusetts Institute of Technology. The method is also illustrated in the last of the forecasting studies in the work.

It would be presumptuous for a reviewer with no practical experience of forecasting to assess the value of the book to the working forecaster. It may be said, however, without fear of contradiction, that to the layman who has already some familiarity with meteorological charts, the book is most acceptable for the insight it gives into the principles on which modern forecasting is based.

F. J. W. WHIPPLE.

PRESERVATION OF ORNAMENTAL TREES

Maintenance of Shade and Ornamental Trees
By Prof. P. P. Pirone. Pp. xvii+422. (New York and London : Oxford University Press, 1941.) 25*s*. 6*d*. net.

SO much can be done with trees to clothe the nakedness of arterial roads and to screen from view the hasty work of the builder in new ‘development’ schemes that a book designed to assist in establishing and protecting trees is welcome. There are districts where it is impossible to restore the ‘rustic scene’ but where, given time, avenues, say, o horsechestnut, or groups by the roadside of suc trees as beech, birch or Norway maple, compensa to some extent for lost amenity. As for trees urban areas there is the example of New York Ci quoted by the author, where nearly a million tr are maintained along some five thousand miles streets.

In the years which immediately preceded the War there was an awakening of the public conscience to the æsthetic value of trees, and societies such as the Council for the Preservation of Rural England an the Roads Beautifying Association did much direct attention to the subject. Numerous bo have appeared dealing with ornamental trees an few have confined their attention to ‘tree surge still there is room for Dr. Pirone’s volume on ‘m tenance’.

The author addresses himself specifically to eastern and mid-western States of America, l readers will find plenty of suggestions applicable conditions in Great Britain.

The author wastes no time in preliminary d cussion; after a brief preface and an introduct note by Dr. L. H. Bailey, he plunges straightv into a concise description of the structure of a t and the functions performed by the various parts. The relation of soil to tree growth is then approached, particularly as regards the soil's physical state and chemical composition, but not forgetting the biological aspect. Emphasis is laid on the importance of the degree of soil acidity or alkalinity, as the case may be, in determining the choice of species. In this connexion a list is given of the *p*H range suitable for the commoner trees and shrubs. If due weight be attached to the other factors, such as elevation, exposure, rainfall, etc., the relative *p*H value will be found to be a useful guide. It is pointed out that most trees prefer soils with a slightly acid reaction, but requirements vary a great deal from the lime-loving to the peat-loving species.

As regards the planting of trees, the author remarks that the methods employed too often resemble an experiment to see how much the tree will stand. Instead of this, of course, the effort should be to reduce so far as possible the shock of removal and to give the transplanted tree a good start. It may be that very few planters will be able fully to follow the author's somewhat elaborate prescriptions, especially in war-time, but it is well to be reminded of the care that should be taken, particularly when trees of large size are being transplanted.

Pruning and the treatment of wounds naturally claim considerable space in this book, for the number of wrong ways of proceeding is remarkable. In Great Britain the section will command the greater attention owing to the unusual amount of damage caused in recent winters by ice and snow. Most of the damage, unfortunately, has perforce been neglected, and wood-attacking fungi will undoubtedly gain a footing if pruning is much longer delayed. To rid trees of their lower branches and produce straight, clean stems is another and quite distinct problem for the pruner which the author discusses, but he makes no mention of 'natural' pruning so familiar and so useful to the forester. It may have been considered outside the province of the 'arborist'. But is it ? In parks, at least, trees can be grown in groups just as easily as singly, and even if individual trees are eventually isolated, the good effects of early massing will be observable in better shape, health and vigour.

Neglected bark-wounds and the removal of large ranches so often lead to decay that a description of e methods of repair forms a fitting sequel to the pter on pruning. The notes on various matters cerning this kind of surgery include specifications he antiseptic dressing of tree wounds and are nctly helpful. As for the treatment of cavities ee trunks, however, it appears doubtful if it is better, in most cases, to let well alone rather to plaster the holes with incongruous stuff such ment, bricks, clay, mortar and asphalt. Gener- peaking, these attempts at arresting decay are and the unsightly patchwork strikes a jarring

aders who turn to the section headed "Trees ole for Streets and Roadsides" will be disap- ed to find that only about fifteen species are with and some of these are dismissed in half a n lines. Many beautiful trees quite well adapted he purpose, such as birch, hornbeam, whitebeam, ring cherries, hawthorns, Nothofagus, Pyrus, itschia, etc., are omitted altogether, or mentioned vhere in the book only in connexion with the ents which occasionally afflict them. Small and ium-sized trees are in many cases more desirable n larger trees for bordering motor roads as their finer leaves decompose more readily and do not cause a skiddy surface.

Passing on to the diseases and insect enemies of trees, we find a somewhat undue proportion (half) of the book is occupied with their discussion. It is to be hoped that would-be planters will not be discouraged by the number and variety of pests, because, apart from a few diseases, for example, chestnut blight and the Dutch elm disease, single trees (as distinct from trees in massed formation) are fairly free from serious infestation. The list of possible dangers—parasitic, non-parasitic and climatic—has an alarming appearance rather out of proportion to the actual risk. Still, if not taken too seriously, there is always the biological interest of diagnosing ailments, studying the pathological symptoms and occasionally endeavouring to treat the complaint. These matters are dealt with helpfully in the text and excellent photographs assist identification.

The book is handsomely turned out, being well printed, well bound, fully illustrated, and provided with a good index and an extensive bibliography. It deserves a good reception from all who have anything to do with the planting and preservation of park, street and roadside trees. Its perusal should correct any tendency to haphazard planting and lead to the better maintenance of the beautiful trees which already adorn the English countryside.

FRASER STORY.

AN INDIVIDUALIST'S PHILOSOPHY

Brought Out in Evidence

An Autobiographical Summing-Up. By William Bowyer. Pp. 424. (London: Faber and Faber, Ltd., 1941.) 15*s*. net.

THIS book is at once a presentation of the author's beliefs about the universe and the record of his own life. Save in the opening chapter, entitled "The Horizon", where he garners the ripe fruits of his spiritual pilgrimage, the philosophy is, with rare artistry, interwoven with the autobiography. Mr. Bowyer could scarcely have done otherwise ; for his speculative outlook is intensely personal. Born in a Battersea slum, into a house clouded by dissension and poverty, where religion meant little but the crude and jealous fundamentalism of Plymouth Brethren and of Strict and Open Baptists ; educated (*sic*) in the elementary and grammar schools of the locality ; harnessed while still a lad to the drudgery of a subordinate post in the General Post Office—such an upbringing was bound to leave an enduring mark on a nature shy, awkward and inarticulate, and at the same time richly gifted and responsive to every stimulus that crossed its path. He hungered for the friendship of those who 'cared' for the things nearest his heart.

Mr. Bowyer is too much of the artist in temperament to rank as a philosopher. His creed is avowedly intuitional, a matter of faith rather than of reasoned evidence. Like D. H. Lawrence, for whose mind he confesses "an awed admiration", he profoundly distrusts the analytic method of the sciences, a distaste probably not lessened by the suspicion that he offers an appetizing bait to the psycho-analyst. No wonder that he early swung free of materialism and scientific determinism, as later on from Socialist and Communist orthodoxies. But the pessimism of his childhood remains unshaken. The marvel indeed is that so sensitive and self-centred a nature should have escaped shipwreck. The thought of suicide, as is evident from the measured discussion in the closing pages of this book, cannot often have been out of mind. It is largely his strong sense of the reality of suffering and evil that makes this biography so arresting and impressive.

Liberation came to him, partly through friendships, still more through his own tough courage—a "Cornish tenacity" inherited through his father—but most of all through conversance with the arts. The effects on his mind of music, painting, sculpture, the Russian ballet, poetry, are traced in full detail in the fourth chapter ("Assimilation and Growth"), the longest and the most illuminating in the book. Mr. Bowyer's views on art are less coloured by emotional bias than many of his other reflections—the unbalanced diatribe against feminism, for example, in Chapter 6 or the extravagant denunciations, scattered up and down the volume, of educational and religious institutions. Yet even where he is most intolerant, there is something engaging in his candour. One of the most interesting passages is on his ideal of political and social reform, where he advocates an original type of State-Socialism, to be applied in the field of economic and material interests, with sedulous precautions against its intrusion into that of spiritual values.

The more philosophical portions of the book are, for the reason already stated, less satisfactory. They state speculative problems rather than answer them. The decisive influence on Mr. Bowyer's mind was that of Bergson, with whose doctrine of intuition he is naturally in sympathy, while dissenting from the narrow role allowed to intellect. His final verdict is for a dualism, naked and unashamed, between matter and spirit, the former being regarded as the source of evil, the latter as creative of eternal values, truth, beauty and goodness, "the greatest of which is Charity". Like T. H. Huxley, he sees the cosmic process in irreconcilable enmity to the moral. But can Nature be branded as immoral without a lapse on our part into the 'pathetic fallacy'? The point, however, in Mr. Bowyer's dualism that most provokes questioning concerns the relationship of the good and evil principles. Reality, he tells us, lies in this relationship; beauty, for example, belongs "to the very flow and creative movement of reality". Is this because the spiritual values have their source in the human mind? If so, since man is integral to Nature, it looks as though the cosmic process generated, not merely its own condemnation, but also the means of its own redemption. Yet we are told that charity, the supreme value, is "in some way an ultimate principle of eternal reality", with a "worth independent of time and place", and as such presumably independent of all temporal process. If this be so, must not the final word lie with the absolute values, and not with the relative and transitory forces of evil? Mr. Bowyer's noble faith in charity, and also in a Universal Mind with which the human mind is absorbed at death, seem to point the way towards a religious *Weltanschauung*, within which Nature as a principle of evil appears as an abstraction. Having gone thus far, Mr. Bowyer, whose whole life-history is a revolt against the abstract, has set himself a problem, the solution of which can only be reached by going still farther.

The author shows himself throughout intensely alive to the cultural influence, not only of his contemporaries, but also of the past. We note, however, a few errors, which do not seriously impair the value of his book. Has any Christian theologian ever thought of the Second Person of the Trinity as "existing before and after as well as during His incarnation, in the same human shape" (p. 33)? Calvin was not a Swiss (p. 80), but a native of Picardy. The Church Catechism does not suggest that everyone should be kept "in the state of life to which it had pleased God to call him" (p. 114); it says "shall please", which is very different. Nor is it true to say (p. 220) that Aquinas's philosophy was based "upon first principles about God", which were "merely affirmed". St. Thomas held that the knowledge of God's existence and of certain of His attributes was demonstrable by natural reason. Finally (*note*, p. 123) it was surely Lord Randolph Churchill, not Lord Palmerston, who "could never understand those damned dots".

W. G. DE BURGH.

MAN'S PRESENT AND FUTURE

The Outlook for Homo Sapiens

An Unemotional Statement of the Things that are Happening to him Now, and of the Immediate Possibilities Confronting Him. By H. G. Wells. (An amalgamation and modernization of two books—"The Fate of Homo Sapiens" and "The New World Order", published severally in 1939 and 1940. Pp. 287. (London: Secker and Warburg, Ltd., 1942.) 8*s*. 6*d*. net.

THE present volume is an amalgamation of two earlier books, "The Fate of Homo Sapiens" (1939) and "The New World Order" (1940). It will be remembered that in the earlier book Mr. Wells stressed the need for some contemporary movement similar to that of the French Encyclopædists of the eighteenth century, so that the human species, now dangerously out of harmony with its environment, might be enabled to make the necessary mental readjustments. He wants a campaign for "a re-invigorated and modernised education", primarily scientific in character.

"The scientific vision of life in the universe and no other has to be his vision of the universe. Any other leads ultimately to disaster. And since the existing educational organisation of the world does not provide anything like that vision nor establis the necessary conceptions of right conduct that ari out of it, it needs to be recast quite as much and ev more than the political framework. This will alm certainly involve such a kultur-kampf as the w has never seen before."

This new education will not stand by itself but be part of a new organization of human life inv ing "outright world-socialism scientifically pla and directed, *plus* a sustained insistence upon law based on a fuller, more jealously conc restatement of the personal Rights of Man". marizing his programme, Mr. Wells speaks of triangle of collectivisation, law and knowledg

Mr. Wells makes short work of current ideol and religions. "There is no creed, no way of li left in the world at all, that really meets the n of the time." He even seems somewhat dub about the Division for the Social and Internati Relations of Science recently created by the Br Association, and says that two divergent tende display themselves in it.

"One is plainly to organise and implement common creative impulse in the scientific min as to make it a vital factor in public opinion; the other is to restrain any such development of an authoritative and perhaps embarrassing criticism of the conduct of public affairs and to keep the man of science modestly to his present subordination."

Mr. Wells is of the opinion that great possibilities await scientific research if his new and stirring education increased the numbers of workers available. "I throw out the suggestion that in our present-day world, of all the brains capable of great and masterful contributions to 'scientific' thought and achievement, not one in a thousand, not one in a score of thousands, ever gets born into such conditions as to realise its opportunities. And of the millions who would make good, useful, eager secondary research workers and explorers, not one in a million is utilised."

Mr. Wells writes with a strong sense of urgency. For the better part of his life this prolific and ingenious writer has been one of the foremost of our propagandists for an outlook which is at the same time scientific and humane. It has now become a question how far the scientific outlook is *necessarily* bound up with humane and liberal ideals, and perhaps Mr. Wells is too ready to take such a connexion for granted. For this reason it is perhaps a pity that Mr. Wells is so impatient of the traditional religions, for, though in the past they may have been, and may sometimes still be, obstacles to progress, yet they too are capable of leading men to make "mental readjustments" of a desirable kind. To take one example. According to the Hindu view of life, when a man has reached a certain age and fulfilled certain responsibilities, he should retire from active life and devote himself to the contemplation of the ultimate mysteries. Mr. Wells might consider this a waste of time; but by banishing all the men of sixty from active life it would ease the situation of those surplus and frustrated young men whose existence Mr. Wells regards as the chief cause of wars.

J. C. HARDWICK.

GENETICS APPLIED

New Paths in Genetics

y Prof. J. B. S. Haldane. Pp. 206. (London: orge Allen and Unwin, Ltd., 1941.) 7*s*. 6*d*. net.

the thirty-three years that have elapsed since Bateson wrote his "Principles", two kinds of y have developed from that book. The one en concerned with digging the foundations of s. deeper and the other with building a ructure of more immediate utility. One has an integration with the physiology and ics of the chromosomes and of the cell; the leading, by a more laborious process, to an tion with plant breeding in general and with problems in embryology, biochemistry and ne.

ar as plant breeding goes, the first attempts ld on the Batesonian foundation were partly ointing. That was bound to be so because in nal genetics of Bateson the chromosomes are as symbols obeying deductively the estab- laws of the subject. Unfortunately, the easiest ements as well as the greatest difficulties in breeding depend on the chromosomes dis- g these laws. Moreover, the statistical instru- for handling plant breeding, even so far as the laws held, were not at first available, and have not yet been systematically applied.

In other directions, however, Bateson's formulæ hold well enough for practical purposes, and it has been possible ever since 1909 to go ahead with elucidating their applications to the problems which other branches of biology are continually putting in our way. In this work Prof. Haldane has played a foremost part. Nor could anyone else have played a similar part. He has been responsible for bringing together the organic chemist and the geneticist in the work of discovering how the genes co-operate in producing plant pigments. He has likewise brought together genetic analysis and the study of abnormal development. He has also, with Fisher, developed a statistical instrument not only for making good the experimental shortcomings of human breeding but also for establishing medical genetics as a discipline of independent value and validity.

This work Haldane has briefly summarized in the present volume. The paths he maps are inevitably far apart from one another, and few readers will be equally interested in the different techniques he describes. Perhaps he might have done more to spread the interest by sparing or explaining his words. For they are, I imagine, the most impressive in strength and variety ever brought together in a volume of this size. But the general reader need not be deterred by these technical expressions, for they can mostly be replaced by symbols without loss to the argument; and in their present context the mathematical equations can be taken as a decoration.

Some readers may feel that if Haldane is approaching his problems in terms of formal genetics he is thereby missing important possibilities of deeper analysis. I do not think he is missing much. A danger lies merely in formal concepts being supposed to have an analytical finality. Two examples of possible misconception may be taken from this book. In *Drosophila melanogaster* and *Zea Mays* it is said "almost every gene has been located" (p. 17). By this is meant analytically "every gene-difference so far detected by experiment". The method of experimental breeding cannot be said to have located every gene since every gene has not necessarily mutated and some genes are not individually detectable. Again (p. 108) it is inferred that "the normal allelomorphs of *W* and *f* control different unit processes", since the abnormal allelomorphs upset the control of these processes. This does not necessarily follow. It is a possibility. In the case of his amorphs, hypomorphs and hypermorphs, Muller has proved that the possibility may be realized. But in the case of other types of mutation he has equally proved that it is not and cannot be realized; which is *a priori* fairly obvious. The gene indeed as it exists in Nature is physiologically a somewhat informal body capable of breaking most physiological rules. The possibilities of rule-breaking that it is not likely to take advantage of are the mechanical ones such as those envisaged by Haldane (p. 110), of its running loose in the cytoplasm. That would be an offence against Nature since the reproductive cycle of the nuclear gene is naturally conditioned by its nuclear environment.

These objections like the others are no hindrance to Haldane's underlying argument. That argument is, in brief, that genetical analysis provides the key to problems in other fields which will baffle the wits and waste the labour of those who attempt to get along without it.

C. D. DARLINGTON.

FOOD PRODUCTION AND NUTRITION

By N. W. PIRIE
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UNDER the general title "Food Production and Distribution in Relation to Nutritional Needs", the recently established Nutrition Society held a meeting on February 28. Papers were read by Sir John Orr on "The Agricultural Implications of a Food Policy based on Nutritional Needs", by Dr. N. C. Wright on "Rival Claims of Animals and Man for Food", by Mr. E. T. Halnan on "Animals as Food Converters" and by Sir John Russell on "Planning for Agricultural Production". Each paper was followed by discussion, but the subjects of the papers were so closely interlocked that there was considerable overlapping of the points made by the twenty-five contributors to the discussion.

After two and a half years of war there is no evidence of a worsening in our nutritional state. Sir John Orr pointed out that, although there are differences between the feeding standards adopted in different countries and by different authorities, these are differences in detail and, broadly speaking, there is now unanimity. At the outbreak of war, both in Great Britain and in the United States, one third of the population fell below this standard ; a decade before that the proportion had been one half. This improvement gives us some cause for satisfaction, but it is clear that in planning post-war nutrition it is insufficient to aim merely at the restoration of the pre-war state. The consumption of foods such as milk might well be increased by 100 per cent in Great Britain, and our agriculture should concentrate on the production of perishable protective foods. In many parts of the Empire, for example India, the need is not confined to special foods, for the nutritional condition is appalling, and more of almost every sort of food is needed.

Both during the War and after it is not sufficient merely to consider which crops should be grown ; research is needed on the more efficient utilization of existing crops and on their improvement. Sir John mentioned, as an example of the former, the possibility of extracting edible protein from grass, "an idea started two or three thousand years ago under royal patronage", and as examples of the latter the production of vegetables richer than usual in minerals and of oats and wheat with an enhanced vitamin B_1 content. The main point brought out in the discussion was the need to ensure that the vitamins originally present in foods such as vegetables are not lost because of the delays in retailing or because of carelessness in cooking. Dr. S. W. Swindells spoke of the "planned destruction of vitamin C in canteen cooking" and referred to cases in which incipient scurvy, caused by this cooking, had been mistaken for pyorrhea.

Dr. Wright showed, in a number of different ways, that in pre-war farming in Great Britain animals were predominant ; for example, the population weighs approximately two million tons and the live-stock five, three million acres were devoted to the direct production of human food and twenty-seven to the production of food for animals, besides which the latter ate two thirds of the imports. This state of affairs has come about because most people prefer the flavour and small bulk of foods derived from animals, and in peace-time there is no real competition between man and animals ; for we get the better parts of the foodstuffs, whether imported or home-grown, and the animals use up the rest. In war-time this luxury cannot be afforded, for animals rarely have an overall efficiency of more than 25 per cent in the conversion of feeding-stuffs into human food.

The productivity of land devoted to the grazing animal is also low : an acre will yield six million calories in the form of potatoes, or three million in the form of wheat but only one million as milk and 200,000 as meat. The ploughing up of three million acres of grass, 15 per cent of the total, must therefore be accepted as a wise policy and it should be remembered that it amounts only to restoring the agricultural balance that existed in Great Britain sixty years ago. The best land was generally ploughed ; the policy therefore led to the loss of about a quarter of the stock-feed produced by grassland. This, together with the restricted importation of feeding-stuffs, has reduced the available fodder to one half. In these circumstances Dr. Wright has argued that it would be unwise to divert any more cattle food into human feeding by increasing the percentage extraction of flour. The raising of the extraction rate from 70 to 75 per cent has reduced the supply of wheat by-products by 400,000 tons and a further rise to 85 per cent will reduce it by 1,000,000. This fascinating, controversial and extremely complicated subject was not, however, argued in any detail at this meeting.

The question of efficiency of conversion of feeding-stuffs into human food was discussed by Mr. E. T. Halnan, Mr. A. N. Duckham, Dr. D. J. Ewing, Dr. J. Hammond, Prof. J. R. Marrack and Prof. D. M. S. Watson. A simple percentage efficiency rarely expresses the matter adequately because many animals can use feeding-stuffs that could, in no circumstances, be used by man. Even when efficiency is considered in terms of protein only, it should be borne in mind that animal proteins are of higher biological value than some of the plant proteins from which they are made. Young pigs and poultry are the only converters that need a type of food substantially similar to that needed by man. Egg production is as efficient as, or more efficient than milk production and some of the concentrates a present reserved for the dairy cow might well released for poultry feeding so long as this foo used primarily for eggs and not for table birds. the allocation of feeding-stuffs more attention s be paid to individual variations between an In general, the young animal is a more e retainer of protein and the old a more e retainer of calories, laid down in the form Since protein is the primary deficiency in th time diet, this would suggest that animals sh slaughtered young, but it can be argued on th side that the adult pig or ox may be eating f which there is otherwise no use. So long, th as they are not allowed to compete with with the, at first sight, younger and more e producers, there is no objection to their reten producers of fat.

Having considered, at some length, the q of the animal's efficiency, the meeting turn brief consideration of our own. Dr. Marrack cr the inefficient distribution of milk and point that there are fines for selling milk of low fat c but not for selling milk rich in bacteria or vitamin A. The lack of any preventive medic the farm and the great losses of feeding-stuffs, caused by the prevalence of mastitis and contagious abortion, were stressed by Dr. W. R. Wooldridge. Individual farmers in the same area may get widely different yields with the same crop. Dr. W. K. Slater asked how great the increase in our productivity would be if every farmer were as skilful as the best farmers, but no one was prepared to answer the question.

The various conflicting interests that have conditioned agricultural policy in the past were considered by Sir John Russell. In the first place the cheapest type of farming in Great Britain would be extensive ranching with few workers and much processing; for, except on a strip up the east coast, our best crops are grass and trees. The essence of planning is that we should decide what is wanted and then guarantee the farmer a market for that crop, otherwise he naturally tends to play for safety and farm in the cheapest way possible. Mr. Halnan had said earlier that the conversion of Great Britain into a "dormitory and exercise ground for animals" is sound economics when imported fodder is cheap, and Dr. F. Yates had explained how a labour shortage tends to encourage stock-feeding. Under planned agriculture half our food should be home-grown, but this does not mean that half of each particular food should be; there should be a great extension in milk and vegetable production. This would mean a decline in home production of wheat, butter and other commodities that keep well and so can be easily transported from abroad. It was noteworthy that the policy of increasing the wheat acreage, except as a purely war-time measure, found no support from any speaker at the meeting; instead there was substantial unanimity that Great Britain should adopt a policy somewhat similar to the peacetime policy of Denmark.

In summing up the results of the meeting, Sir Joseph Barcroft pointed out that, whereas a Government committee consists of men who have been carefully selected for reasons not always connected with their scientific attainment, it was open to anyone with knowledge to have his views heard at meetings such as this. He suggested that a channel should be established through which any agreed plan of action could be brought to the attention of the Government. The speakers who had urged on those responsible for the planning of diet the need for making that diet appetizing had his wholehearted agreement. The Society presumably claims no particular originality for this point of view, an earlier authority having remarked:

> Now, good digestion wait on appetite,
> And health on both!

UNITED STATES ANTARCTIC EXPEDITION, 1939–41

A SYMPOSIUM on the scientific results obtained by the United States Antarctic Expedition, 1939–41, was arranged by the American Philosophical Society at Philadelphia on November 21 last.

Prof. F. Alton Wade, professor of geology, Miami University, and senior scientist of the U.S. Antarctic Service, gave an introductory paper, in which he stated that one of the primary purposes of the Expedition was to carry on a comprehensive programme of scientific observations and research. A great portion of the programme was carried to completion by the twenty-one members of the scientific staff; due to an unexpected termination of the expedition, some phases were only partially completed. Detailed observations were made and programmes of research were conducted in the following fields: auroral phenomena, bacteriology, botany, cosmic rays, glaciology, magnetism, medicine, meteorology, micropalæontology, ornithology, petrography and petrology, physiography, physiology, radio, seismology, structural geology and zoology. Among the reports in preparation are the following: observations and height determinations of the aurora australis; the physiographical features of the Ross Shelf ice; the geology of the Weddell coast of Palmer Peninsula south of 68° S.; the geological features and formations in the vicinity of East Base; the sedimentary rocks of the Edsel Ford Mountains; the petrography and structure of the Rockefeller Mountains; ornithology report, which will include observations of bird life at both bases, at the Melchior Islands and along the ships' routes; the petrography and structure of the Melchior Islands; a correlation of radio receiving and transmitting conditions with magnetic phenomena and auroral displays.

Paul A. Siple, of the U.S. Antarctic Service, said that geographical exploration was carried on from West Base in 1940 by means of five reconnaissance field parties and two aircraft. The routes used followed but extended considerably beyond those opened first by the Byrd Expeditions of 1929 and 1934. The field parties' operations were limited to the hinter-coastal mountains east of Little America from long. 164° W. to long. 136° W. The parties were occupied mainly with surveying, geology, biology and meteorology. Aerial reconnaissance and surveying extended eastward to long. 120° W., including the major land features to nearly 200 miles south of the coast. This was accomplished by six flights, making more than a thousand usable aerial survey photographs available of the area.

Exploration to the west of Little America included three major flights over previously explored portions of the Ross Ice Shelf, crossing in each case into meridians of east longitude in the vicinity of lat. 78° 30′; 79° 20′; 81°; 83°; and 84°. Four newly discovered areas of internal disturbance were studied and fifteen bays and inlets were photographed in the continuous aerial survey of about four hundred miles of Barrier face from an altitude of 7,000 ft.

Southern exploratory operations were confined mainly to filling in the gap of mountains in the Austral Cordillera between Beardmore and Live Glaciers. However, the character of land formations east of the 120th meridian west indicated that there is no sea-level connexion between the Ross and Weddell Seas.

Other geographical accomplishments included glacial studies of the formation and physiography of shelf ice, problems of human adaptation to the climate of Antarctica, and studies of the cooling power of the wind.

An account of the geology of the large ranges around Little America was given by Lawrence A. Warner, of Johns Hopkins University.

The physical aspects of shelf ice were described by Prof. Alton Wade. The first detailed investigations of shelf ice were made at West Base during 1940. Included in the programme were the following: the variation of the density of the firn with depth, subsurface temperature measurements to a depth of 41 m., variations in the snow surface-level over a period of eleven months, horizontal and vertical movements within the firn, variations in the size of the constituent grains in various zones, stratification and horizontal banding. The results, presented in tabular and graphic forms, were compared with those obtained from investigations of the physical aspects of other types of glaciers; namely, valley glaciers and the Greenland Ice Cap. The lack of summer melt-water in the Ross Shelf ice eliminates what had been considered the most important factor in the process of firnification. However, without the aid of melt-water, the process does proceed with much the same results. An explanation of the firnification process in regions where the air temperature seldom rises above freezing was advanced.

Herbert G. Dorsey, jun., of the U.S. Weather Bureau, described some of the meteorological work. The programme at the East Base included the establishment of a completely equipped weather outpost more than a mile above sea-level on the plateau of Palmer Peninsula, Antarctica. Early in August 1940 a sledging party from East Base found a route to the plateau, making an ascent which previous explorers considered inaccessible to dog teams, and indicating the possibility of erecting a mountain weather station. Late in October, nearly 1½ tons of equipment were transported by four dog teams to the proposed meteorological outpost, located at 68° 7′ S., 66° 30′ W. on a plateau knoll about 12 miles east of the main base. Lester Lherke and Robert Palmer occupied the plateau weather station during November and December.

Despite prevailing north-easterly storms of drifting snow, Messrs. Lherke and Palmer spent their time between living quarters in a sturdy tent and a meteorological 'office' in a snow cave. For the first time in south polar regions, detailed high-level weather data were obtained in a form suitable for comparison with nearby sea-level observations.

Six-hourly check readings on all data were taken concurrently with those at East Base, in addition to the continuous autographic records of wind, pressure and temperature. Snow accretion and ablation were measured. Pilot balloon observations of the winds aloft were especially valuable when there was a low overcast below the plateau.

The mountain station was in contact with the base twice daily by low-power radio, sending coded weather reports which were included in the East Base weather transmissions to South America. These data, and frequent special reports, were helpful in forecasting for aviation operations at East Base and provide interesting material for future research on the meteorological phenomena of Palmer Peninsula.

A preliminary report on the magnetic and seismic programme was given by Roy G. Fitzsimmons, of the U.S. Antarctic Service and the Carnegie Institution of Washington. During the period April 27, 1940–January 21, 1941, a LaCour insensitive magnetograph was in operation at Little America. Variations of the declination and the horizontal and vertical components of the earth's magnetic field were recorded. Control observations were made with a magnetometer and a dip circle. A general description of the magnetic observatory and the method of observation as well as a report on the preliminary magnetic results were given. During the period November 17–December 28, 1940, a McComb-Romberg seismograph was in operation at the Rockefeller Mountains. A report of the earthquakes recorded and analyses of them were given.

Prof. S. A. Korff, assistant professor of physics, New York University, discussed the cosmic ray programme, which was planned with the view of throwing further light on the connexions between cosmic rays and meteorology, and also on the effects produced by such high-energy rays passing through matter. The first part of the programme involved the operation of two meters at West Base throughout the antarctic winter and a correlation of the records obtained there with temperature, pressure and other effects such as magnetic variation; and also the operation of the instrument on board ship to obtain further data regarding the temperature coefficient and the latitude-variation. Finally, aeroplane flights to high altitudes were carried out, which were to be studied in connexion with *radio sonde* data. The second part, namely, studying the effects produced by the radiation, involved (*a*) operating a cosmic ray counter on shipboard for comparison with the electroscope data, (*b*) the operation of a neutron counter, and (*c*) measurement of all bursts in the cosmic ray intensity on the long-term records.

With respect to the first part, a pressure coefficient was determined from the data at West Base for each 15-day period of operation. It was found that the least-square solutions of the correlation between pressure and cosmic ray intensity gave a slope (pressure coefficient) and an intercept (the extrapolation of the cosmic ray intensity to zero pressure) both of which varied over somewhat wider limits than were anticipated. Further analysis showed that this variation was associated with changes in the height of the mesotron-producing layer, but that contrary to the usual procedure in temperature latitudes, this could not be represented as an external temperature effect. This was found to be due to the fact that the surface temperature was not a good indicator of the distribution of the atmosphere in the column of air above the instrument. Using the *radio sonde* data, a new dependence upon upper atmosphere conditions was computed, and better agreement was obtained. This was checked by the runs made on shipboard in zones of different surface temperatures. The reduction of the observations was partly supported by a grant from the Penrose Fund of the American Philosophical Society.

A report by Arnold Court, of the U.S. Weather Bureau, dealt with the complete disappearance of the tropopause during the antarctic winter. This was revealed by the 190 *radio sonde* observations made during April 25, 1940–January 15, 1941, as part of the U.S. Weather Bureau's share in the scientific programme of the Expedition.

Summer-time observations show a definite and rather warm (−50° C.) tropopause around 9 km., above which the stratosphere is −40° C. or warmer. Spring and autumn soundings clearly show the transition from the winter type, with no clearly defined stratosphere, and with temperatures to −80° C., to the summer condition. This hitherto unsuspected behaviour of the upper air apparently is due to seasonal differences in radiation, but no indications of such conditions have so far been reported in the northern hemisphere, despite daily soundings at Barrow, Nome, Fairbanks, and other Alaskan stations, and intensive work in the U.S.S.R. and Scandinavia. None of these stations, however, is so close to the pole as Little America III (800 miles).

Another phase of the meteorological programme, the making of 230 pilot balloon ascents, revealed the prevailing summer-time wind at high levels to be south-west or west-south-west, not north-west as had previously been assumed. On the surface, observations covering an entire year were obtained, eleven months of them on a complete 4-a-day basis. Barograms were obtained in duplicate for the entire time, and thermograms except when winter cold stopped clocks. Complete wind records minute by minute were obtained from April 10 to camp abandonment on February 1.

Ernest E. Lockhart, of the Massachusetts Institute of Technology, described physiological investigations which were undertaken. An attack on the problem of acclimatization by white men in the antarctic was made by studying the effect of sudden changes in temperature on blood pressure, heart-rate and respiration-rate. This work was extended with data on 'normal' body temperature, blood pressure, heart- and respiration-rates and metabolism under basal conditions. A study of blood sugar levels was also made. Although pulse pressure is not effected significantly, systolic and diastolic pressures increase 25–35 per cent when a sudden change in temperature is the stimulus. Both the respiration-rate and the heart-rate are decreased somewhat. Under 'normal' basal conditions, pulse and respiration-rates, blood pressure and body temperature are slightly lower than normals recorded in temperate climates. Basal metabolism averages 10–15 per cent lower than that reported for temperate climates. Blood sugar levels, on the other hand, are slightly above the normal limit of 120 mgm. per cent.

Although the results presented should be extended, those now at hand indicate that acclimatization does take place in white men when subjected to the extreme conditions prevalent in the antarctic. It is suggested that the acclimatization process is begun by the continual pressor action of the low temperature. This primary stimulus, when repeated frequently, as is this case, induces hypo-effects in the several endocrine systems principally involved in metabolism.

Other papers were by Herwil F. Bryant, of the National Research Laboratory, Anacosita Station, Washington, D.C., on biological problems at East Base, J. E. Perkins, of the U.S. Biological Survey, on the biology of the West Base region, and Richard H. Black, of the U.S. Department of the Interior, on operations in Palmer Land.

CRYSTALLOGRAPHY AND PLANT VIRUSES

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Of the many techniques introduced into research on viruses during recent years, none has aroused more interest than those of the crystallographer. The value of these techniques in such work is amply shown by three recent papers* by Prof. J. D. Bernal and Dr. I. Fankuchen. The authors describe these papers as "only a preliminary and rough survey" and state that "many more years of work will be needed before exact and reliable interpretations can be expected". No doubt this is true. Nevertheless, what has already been done has greatly widened our understanding of viruses, in addition to bringing to light unsuspected properties of colloidal aggregates.

Before 1936 it was tacitly assumed that all viruses were incompressible spheres, and all calculations of their sizes were made on this basis. A cursory examination of the optical properties of purified preparations of tobacco mosaic virus was sufficient to show that this assumption was invalid and that the virus particles were anisodimensional. X-ray analysis soon showed that they were rods at least ten times as long as they were wide. Their width was found to be 152 A., but their length was too great to be measured by X-rays, although by means of specially designed cameras, spacings greater than 1000 A. were measured. Later work on sedimentation and diffusion constants, viscosity and with the electron miscroscope have all confirmed the size and shape first indicated by crystallographic studies.

One of the most interesting properties of solutions of tobacco mosaic virus of sufficient purity and concentration is their separation into two liquid layers, the separation occurring at increased dilutions with increasing purity. The denser phase is also the more pure. It is formed by the fusion of tactoids, and the suggestion offered by Prof. Bernal and Dr. Fankuchen that the cusps of the tactoids are occupied by particles of impurities explains many of the observed phenomena.

X-ray measurements have been made on dried preparations of tobacco mosaic virus and on solutions of varying concentrations. The pattern obtained falls into two parts: one of large spacings obtained with cameras working at very low angles, and the other of smaller spacings obtained with high-angle photographs. The first part of the pattern varies, the spacings depending on the *p*H and concentration. At the same *p*H, the spacings increase with increasing dilution, and at a constant concentration they decrease as the *p*H approaches the iso-electric point. Variations in the amount of water separating the virus particles are clearly responsible for these differences.

These patterns give us information on the effective size of the virus particles and also reveal previously unsuspected regularities in the structure of solutions. They show that the distance between the rods is inversely proportional to the square root of the concentration by volume, and that the particles are distributed in a hexagonal array so as to fill the available space as uniformly as possible. This regularity of packing of the long virus particles is typical of all orientated purified preparations, whether as fluid, gels or as the crystal-like needles produced by precipitation with acid or salts. In all states the particles are equidistant and parallel, but there is no evidence of any regular arrangement in the direction of the length of the rods. This is in striking contrast with the condition inside the infected plant, where true crystals with a three-dimensional regularity occur, and confirms other evidence that the processes of purification alter the viruses, probably by causing them to aggregate end-to-end.

The high-angle photographs give us our main information on the internal structure of the virus particles; surprisingly enough, the clearest have been given by orientated solutions of tobacco mosaic virus. The patterns from these photographs show that the particles have an internal regularity similar to that of crystals. Thus the virus preparations are in a sense doubly crystalline, for the components of the particles, in addition to the particles themselves, are regularly arranged. Their structure is more complicated than the anisotropic protein myosin but less so than pepsin. There is a spacing along the length of the particle of 11 A., and the virus seems to be composed of piles of sub-molecules with dimensions of 11 A. cubes. The spacings in the high-angle photographs are independent of the water content of the preparation, showing that even in solution the particles contain no appreciable amount of water. It is their internal regularity, lack of water and chemical simplicity that separate the viruses most sharply from the simplest recognized organisms.

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* 1. "Introduction and Preparation of Specimens"; 2. "Modes of Aggregation of the Virus Particles"; 3. "X-Ray and Crystallographic Studies of Plant Virus Preparations", *J. Gen. Physiol.*, 25, 111–65 (1941).

Most of the work has been done with tobacco mosaic or closely related viruses, but some photographs have been taken of potato virus *X* and tomato bushy stunt virus. The last has spherical particles and crystallizes as rhombic dodecahedra, from which patterns were obtained with both high- and low-angle photographs. Each virus gives its own distinct pattern, and differences were even detected between related strains of the same virus, but the different viruses resemble each other more than any other type of proteins yet examined by X-rays. The differences found are of the order to be expected from a knowledge of the chemical, serological and physico-chemical properties of the viruses examined.

It is obvious that this work has opened up a field of research that promises to be extremely fertile. In virus research these techniques will be limited in their application by the difficulties of preparing most viruses, because of their small concentration in the host and their instability, in a form suitable for crystallographic studies. But with the extension of X-ray analysis to spacings as great as 1000 A. and the improvements in the electron microscope, particles of all sizes from bacteria to atoms become capable of direct examination, and a serious gap in our techniques for the examination of colloidal particles has been filled.

OBITUARIES

Captain T. A. Joyce, O.B.E.

THOMAS ATHOL JOYCE, who died at Hoveton, Norfolk, on January 3, was born in 1878, and was the eldest son of Thomas Heath Joyce, editor of the *Graphic* and the *Daily Graphic*. He was educated at Dulwich and Hertford College, Oxford, where he took his degree in 1901 and then studied Egyptology. He entered the British Museum as an assistant keeper in the Department of British and Medieval Antiquities and Ethnography under the keepership of Mr. (later Sir) C. Hercules Read. From the first he specialized in anthropology and was the first Museum officer to give his full time to the Ethnographical Collections including the American antiquities. He introduced considerable rearrangements in the Ethnographical Gallery, and prepared the greater part of the first "Handbook to the Ethnographical Collections", published in 1910 (second edition, 1925), which was essentially a condensed text-book of ethnology, liberally illustrated by specimens in the Museum. Thus he may be said to have laid the foundations of an Ethnographical Department as a distinct entity, destined, one may hope, to take ultimate shape as an independent Museum.

Joyce's attention was at first devoted principally to Africa, and by collaborating with the late Mr. Emil Torday, he secured for the Museum a splendid and well-documented collection from certain tribes of the Belgian Congo, principally the Bushongo, which surpasses both in quantity and quality any other single collection from the African continent in the Museum. Together with Torday he prepared two important monographs of these tribes, "Les Bushongo" (1910) and "Les Basonge, etc." (1922), published in the *Annals* of the Musée du Congo Belge. Afterwards his chief interest shifted to the archæology of Central and South America, where it remained for the rest of his life. These studies were stimulated by his friendship with Sir Clements Markham and Dr. Alfred P. Maudslay, and resulted in a series of authoritative text-books: "South American Archæology", "Mexican Archæology", and "Central American Archæology", which appeared in quick succession in 1912, 1914 and 1916. These were pioneer books, which for the first time presented to the student and general reader in a handy and condensed form a great mass of archæological data, hitherto scattered in a variety of monographs in different languages and not easily accessible. Although no longer wholly up to date, they remain standard works of reference, and have not been superseded.

During the War of 1914–18 Joyce's services were transferred to the War Office, where he became hon. lieutenant attached to the General Staff in 1916, and captain in 1917, receiving the O.B.E. in 1918.

After the War, and following on Read's retirement in 1921, he became deputy-keeper of the new Department of Ceramics and Ethnography, and reorganized the ethnographical section. He arranged for the transfer of the magnificent Maudslay Collection of Maya plaster-casts from the Victoria and Albert Museum, and for their exhibition in a special room in the British Museum, while he prepared the official "Guide to the Maudslay Collection of Maya Sculptures from Central America", published in 1923 (second edition, 1938). Of a more popular character was his "Maya and Mexican Art" (*Studio*, 1927), a most informative and attractively illustrated volume.

Joyce had always wanted to do field work, but the opportunity was late in coming to him. However, during 1926–1931, he organized a succession of expeditions to British Honduras on behalf of the Museum, four of which he led in person. These produced a rich harvest of finds, particularly from the "Old Empire" sites of Lubaantun and Pusilhá, including a number of inscribed stone stelæ and a large series of pottery whistle figurines of a new type. Illustrated reports of these expeditions were published in the *Journal of the Royal Anthropological Institute*.

Ever since 1902 Joyce had been closely associated with the activities of this Institute, of which he was honorary secretary and editor during 1903–1913, vice-president, 1913–17 and 1923–25, and president, 1931–33. Throughout this period he devoted much time and energy to furthering the aims of the Institute, attended its meetings, and was a frequent contributor of original articles and reviews to its *Journal* and to *Man*. He took an active part in organizing the exhibition of "Indigenous American Art" at the Burlington Fine Arts Club in 1920, the catalogue for which was prepared by him.

He was president of Section H of the British Association in 1934, his address taking the form of an original piece of research into the origins of yerba maté or 'Paraguayan tea'. He contributed articles to the "Encyclopædia Britannica" and to a number of more popular serials such as Harmsworth's "Universal History of the World" and Hammerton's "Wonders of the Past", as well as to certain foreign scientific journals. He was honorary secretary of the Hakluyt Society in 1923. In 1938, at the age of sixty, he retired from the British Museum owing to ill-health.

In spite of his erudition in his chosen subjects of ethnology and American archæology, Joyce carried his learning lightly, and his work was infused with an unaffected gaiety. Possessed of a happy and sociable temperament, and a ready wit, he never wearied of introducing students or visitors to his favourite subjects, or of trying to inspire in them a genuine interest in the collections under his charge; his influence led to a number of important benefactions, and was felt indirectly in many ways. As a foremost authority on all aspects of American archæology he leaves no immediate successor in Great Britain.

It was with sincere sorrow that his many friends noted, during his latter years, the signs of failing health in a constitution never very robust. But while illness inevitably led to the curtailment of his scientific work, it never succeeded in quenching the indomitable cheerfulness of his spirit.

He is survived by Mrs. Joyce, herself a leading authority on the Latin American countries, though perhaps better known to the public under her maiden name of L. E. Elliott. He had three children by an earlier marriage. H. J. BRAUNHOLTZ.

WE regret to announce the following deaths:

Sir William Bragg, O.M., K.B.E., F.R.S., director of the Royal Institution of Great Britain, and, during 1935–40, president of the Royal Society, on March 12, aged seventy-nine.

Prof. Lawrence J. Henderson, professor of chemistry in Harvard University, foreign secretary of the U.S. National Academy of Sciences, aged sixty-three.

Dr. George Senter, formerly principal of Birkbeck College, University of London, on March 14, aged sixty-eight.

NEWS and VIEWS

India

THE announcement made by Mr. Churchill in the House of Commons on March 11 that definite proposals have been formulated, and are being submitted to the leaders of Indian thought, for terminating the state of political unrest in that great country, will be welcomed on all sides. The Government made a pronouncement in August 1940 of the general principles upon which British rule in India was proceeding, indicating that full Dominion status would be granted as soon as possible after the War, under a constitution to be framed by Indians and acceptable to the chief elements of Indian national life, subject to the protection of minorities and to the fulfilment of Imperial obligations to the native States. This promise did not satisfy certain classes of opinion, and there has been bitter controversy, notably between the Congress party and the Moslem League. Reference has been made in NATURE on several occasions to the difficulties of the situation, and a noteworthy and constructive article on the subject by Sir Denys Bray, formerly Foreign Secretary, Government of India, appeared in NATURE of September 13, 1941, p. 301.

Mr. Churchill has now stated that the War Cabinet has agreed upon certain "conclusions for present and future action", based upon the general declaration already referred to, and Sir Stafford Cripps has volunteered to take these proposals to India. There he will strive to obtain the necessary assent to them from the chief parties of the country. In view of the grave turn taken by the War in the Far East, Sir Stafford will also consult with the Viceroy and Commander-in-Chief regarding the relation of these proposals to the defence of the country. The intervention of the War Cabinet at this critical juncture is a measure of the importance attached to the promotion of unity of purpose and action in India, and the outcome of Sir Stafford Cripps's mission will be awaited with keen interest.

Wheatmeal Flour and Bread

SPEAKING in the House of Lords on March 11, Lord Woolton, Minister of Food, announced that in order to reduce the very considerable tonnage of shipping used for the import of wheat into Great Britain, the Government has decided to increase to 85 per cent the ratio of flour from wheat milled in the country. From March 23 millers will be prohibited, except under specific licence, from manufacturing any flour other than wheatmeal flour, or some authorized speciality brown flour. This increased milling ratio entails the diversion of some of the products of wheat from the feeding of livestock to use as human food. But the change has been timed to take place when, with the approach of summer, it will not be necessary for the Ministry of Agriculture to change, from now until the end of August, the scale of rations of purchased feeding-stuffs allowed to stock and poultry feeders.

In order to absorb the stocks of white flour, no miller, factor, or importer will be permitted to deliver any white flour to any person other than a licensed baker, and then only providing that three times the quantity of national wheatmeal is concurrently delivered. Further, bakers will be authorized when producing national wheatmeal bread to include up to 25 per cent of white flour with the national wheatmeal. From April 6 it will not be permissible, except under licence, to sell any white bread, and a similar order referring to the use of flour in any other item of food will come into effect on April 20. Lord Woolton said that, while complete uniformity in the production of wheatmeal flour and bread is not possible, he is satisfied that we shall get a good bread, good in substance, good in texture, and agreeable to the palate. The composition and nutritive value of wheatmeal and similar bread have frequently been discussed in NATURE; attention may be directed especially to articles in the issues of May 31, 1941 (p. 665) and August 23, 1941 (p. 219).

Mechanical Engineers in the Army

ONE of the recommendations of the Beveridge Committee on Skilled Men in the Services was for the formation of a Corps of Mechanical Engineers in the Army (see NATURE, March 7, p. 255). Replying to a question in the House of Commons on March 11, Mr. Duncan Sandys, Financial Secretary to the War Office, referred to this proposal to pool the mechanical engineering resources of the various Corps. He said that it has now been decided to bring together the greater part of the Army's engineering maintenance services and to form them into a new and separate Corps. The new Corps will be made up of three principal components: first, the entire engineering side of the R.A.O.C.; second, all the maintenance personnel of the R.A.S.C., with the exception of formation workshop platoons and independent companies; and third, a large part of the mechanical maintenance personnel of the Royal Engineers. These far-reaching measures of reorganization would entail not only extensive administrative changes but also large-scale transfers of personnel.

Nervous Shock in Peace and War

AT a Chadwick Public Lecture delivered on March 17, Dr. William A. Brend considered nervous shock in peace and war. 'Nervous shock' is the same whether it is called 'nervous shock', 'shell shock' or 'traumatic neurasthenia' or any other of its names. Evidence of nervous shock can be found in early records, for example, in the Book of Job. Shakespeare gives an astonishingly accurate picture of 'battle-shock' in Henry IV. The modern history of the disorder begins about the middle of the nineteenth century when numerous cases were attributed to railway accidents. Many cases were seen in the Army during the War of 1914–18, and after the War a committee of investigation reported that the term 'shell-shock' had been "a gross and costly misnomer" which had done much harm. The essential cause of nervous shock is fear, but the effect of fear is often increased by injudicious 'suggestion'. Physical injuries play no part in the production of the disorder. Civilians suffering from shock after air-raids are not entitled to compensation under the Personal Injuries Act. Reasons were given for thinking that this was a very wise decision of Parliament. The influence of temperament was briefly discussed.

The biological significance of fear as an instinct was then examined. Capacity to feel fear is part of our normal mental make-up, and of the defence mechanism of the species. Fear only becomes a matter of self-reproach (that is, cowardice) if it is uncontrolled. Man then sinks to the level of the brutes and sacrifices the benefit of his intelligence. The public health aspect of nervous shock arises from the fact that the affection differs from organic disease or injury in that medical men are not considered to have a monopoly of the knowledge concerning either the cause or the pathology or the proper treatment of the disorder. There is a definite public opinion on all these questions which expresses itself through the Press and influences Acts of Parliament, provision of treatment and claims for damages, etc., in courts of law acting through judges and juries. It is very important, therefore, that this public opinion should be based on accurate knowledge. There are reasons for thinking that this is not the case at present, and indeed that in certain directions encouragement is given to the development of the disorder. Increased understanding of the nature of the condition would accordingly help to reduce its incidence.

Physical Society Optical Group

THE inaugural meetings of the newly formed Optical Group of the Physical Society were held on March 6 at the Science Museum and the Imperial College, South Kensington. It is ten years ago since the Optical Society was merged with the Physical Society, and although in this period a good number of meetings have been devoted to optical subjects, there has been a widely expressed desire for the formation of a Group for discussions and lectures of a less exacting and critical character than those associated with papers intended as original contributions to science. A preliminary meeting was held in December 1941 at which a draft constitution was approved, the objects of the Group being the provision of opportunities for the meeting of those with optical interests, the promotion of research and education in optics (including the improvement of optical literature), and fostering public interest in this branch of science. The first business of the inaugural meeting was to adopt the Constitution, and to elect Dr. A. O. Rankine as chairman with Prof. L. C. Martin as honorary secretary. A representative committee consists of Instructor Capt. T. Y. Baker, Mr. R. J. Bracey, Mr. W. H. A. Fincham, Dr. V. G. W. Harrison, Mr. W. C. Hynd, Dr. H. Lowery, Capt. T. Martin, Mr. J. Perry and Mr. E. W. H. Selwyn.

The first lecture was delivered by Dr. W. M. Hampton (Messrs. Chance Bros. and Co., Ltd.) who took as his subject "Some Problems relating to Optical Glass", dealing especially with recent work on the effects of heat treatment on the optical properties of the medium. The meeting in the afternoon was devoted to a paper by Mr. R. J. Bracey describing "A Multi-purpose Collimator" and a discussion, opened by Mr. J. Perry, on "Thermal Effects on the Performance of Lens Systems". Both subjects provoked a good discussion in which valuable technical points were brought out. Upwards of fifty members attended a luncheon at which Profs. A. V. Hill and A. C. G. Egerton, secretaries of the Royal Society, were guests of the Physical Society. In proposing the toast "The Optical Group", Dr. Rankine said the membership already includes 127 names. He hopes that the formation of the Group will be of value in the scientific life of the country, and that where papers of optical interest are forthcoming they will in future be made available for discussion by its members. Exacting demands are being made upon the optical industry in Great Britain, and the new Group can do considerable service if it leads to increased co-operation among those whose duty and honour it is to be called upon to fulfil them.

Royal Microscopical Society (1839–1939)

THE recent publication of the presidential address delivered by J. E. Barnard before the Royal Microscopical Society (*J. Roy. Mic. Soc.*, 61, 1; 1941) in celebration of its centenary, and the republication in the same journal of the address given in 1895 by A. D. Michael (the president in that year) calls forcibly to mind the comparatively recent advent of the microscope particularly as applied to the variety of fields in which it is now so familiar. At the time of the foundation of this Society, microscopes were primitive and were generally regarded as playthings compared to the telescope, although Lister had already published his epoch-making paper on the achromatic objective. The paucity of microscopical research in Great Britain had, in fact, already been noted by Schleiden, a slur which the Society was to do much to remove. Under Prof. Owen as first president the Society flourished from the start, and the first number of the *Journal* was published in 1841. One of the main features of the early meetings, attended in the nature of things almost exclusively by amateurs, was apparently the rapid introduction of new types of microscopes and much enthusiasm over technical improvements upon old. Among the members of the time we may note such names as John Queckett, Michael Faraday, Thomas Bell, with Ehrenberg as the first honorary fellow. Throughout its life the Society has stimulated interest not only in improvement of instruments but also in perfection of microscopical technique. The use of Canada balsam had been described shortly before the foundation of the Society, but it was not until 1848 that the use of glycerine was noted by Warrington.

In its first fifty years the Society achieved much—the homogeneous immersion lens suggested by Stephenson and worked out by Abbe, the binocular microscope, the Society's standard screw for objectives, the mechanical substage and hundreds of other improvements large and small—and in its *Journal* were presented many epoch-making papers the authors of which are now almost forgotten but whose work has formed a sure foundation for modern studies. In more recent times the Society has become progressively professional. Among the outstanding features of these later years we may recall the controversy over Abbe's diffraction theory of microscopic vision, with E. M. Nelson and J. W. Gordon as the more notable figures and calling to mind such great names as Sylvanus Thompson and Lord Rayleigh, a topic which has arisen from time to time during ensuing years, culminating in 1928, when it was generally agreed that under the conditions of illumination commonly employed the theory is no longer tenable. In 1902 Siedentopf introduced the ultra-microscope and in the following year the first paper appeared on ultra-violet light microscopy, marking perhaps the most important advance during the present century. The basis for the modern standard of procedure in microscopy was laid by Nelson in 1910 in a description of his method of "critical microscopy". Since that time, perhaps one of the more notable advances with which the Society has been connected is the improvement in design and the use of the polarizing microscope figuring so largely in current microscopy. It is confidently to be expected that in the future the Society will continue to serve microscopy with the same success as in the past. (See also NATURE, 144, 850; 1939.)

The Australian Anthropological Association

IN 1939 the Australian Anthropological Association was formed after discussion between the Anthropological Associations of New South Wales, Victoria and South Australia at the meeting of the Australian and New Zealand Association for the Advancement of Science held in Canberra that year. The headquarters of the new Association are to be situated in rotation for a period of two years in each State of the Commonwealth in which there is an anthropological society affiliated with the Association. During the first two years of its existence the headquarters of the Association were in Adelaide. Now they are at Sydney and will remain there until October 1, 1943, when they will be transferred to Melbourne. The official organ of the Association is *Mankind* which is the official journal of the Anthropological Society of South Australia. Officers of the Association are as follows: *President*, Prof. A. P. Elkin; *Vice-president*, Mr. F. L. S. Bell; *Hon. Secretary-Treasurer*, Mr. G. W. Watkins ("Hansard" Staff, Parliamentary House, Sydney).

Early Civil Engineering in France

IN a paper read to the Newcomen Society on March 11 entitled "The French Civil Engineers of the Eighteenth Century", Mr. S. B. Hamilton gave an account of the Corps des Ponts et Chaussées, founded in 1716, and of the school established in 1747 in connexion with it. The Corps was responsible for the main roads, canals, bridges, etc., of the country, and it has had many distinguished men on its staff. These men, such as Gautier, Frézier, Perronet, Gauthey, Chezy and Prony, possessed high scientific attainments, and in their memoirs and textbooks they established many of the principles underlying constructional work. When Telford looked for the literature of civil engineering, it was to France he turned, and his collection of books was bequeathed to the Institution of Civil Engineers. The outstanding man of the eighteenth century was Perronet (1708–94), who entered the Corps in 1745 and became director of the École des Ponts et Chaussées in 1747. His bridges, said Mr. Hamilton, were remarkable for boldness of design. Moreover, in an age of corruption, he set his face against the patronage which ruined some civil administrations; he selected his subordinates strictly on the grounds of ability and character.

Indian Journal of Genetics and Plant Breeding

THE formation of the Indian Society of Genetics and Plant Breeding at New Delhi in January 1942 has been quickly followed by the publication of the *Indian Journal of Genetics and Plant Breeding*. This journal is edited by Dr. B. P. Pal, Imperial Agricultural Research Institute, New Delhi, on behalf of the executive council of the Society. This welcome addition to genetical publications provides a valuable outlet and source of reference for the ever-increasing work of the research institutes of India. The volume for 1941 consists of one part, but in the succeeding years it is intended to publish twice a year.

In the first volume there are articles on hybrid vigour in rice by K. Ramiah and K. Ramasamy, chlorophyll deficiencies in rice by B. S. Kadam, colchicine induction of polyploids in *Capsicum annuum* by B. P. Pal, S. Ramanujam and A. S. Joshi, cytology of sterile *Sesamum orientale* by L. S. S. Kumar and A. Abraham and vernalization of Indian crop plants by B. P. Pal and G. Suryanarayana Murty. The Agricultural Commissioner with the Government of India, Dr. W. Burns, in the first paper of the publication, points out the great opportunities for plant genetics and plant breeding in India and welcomes the advent of the Society and *Journal*.

Smithsonian Institution Activities

THE report of the Secretary of the Smithsonian Institution and the financial report of the Executive Committee of the Board of Regents for the year ended June 30, 1941, includes a summary of the year's activities and reports on the United States National Museum, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Observatory, the Division of Radiation and Organisms and other activities (Washington: Gov. Printing Office. 25 cents). The Smithsonian Institution has already been assigned a number of defence problems. The revision of all solar-constant values collected by the Astrophysical Laboratory from all Smithsonian observing stations from 1923 to the present is nearing completion and publication is expected to commence in 1942. A promising method has been developed of following the sun's variation by observations limited to the blue-violet region of the spectrum.

The Division of Radiation and Organisms has continued its studies on the relation of radiation to various phases of plant growth, and much information has been acquired on the respiration of etiolated barley seedlings. In addition to improvements in the performance of the spectrograph used in measuring carbon dioxide for very short periods, the spectral effectiveness of radiation for the growth inhibition of the oat mesocotyl has been further studied, as well as those of other species of grasses, and the ultra-violet irradiation of algæ. M. W. Stirling has made further archæological discoveries in southern Mexico in co-operation with the National Geographic Society, and Dr. Frank H. H. Roberts, jun., has completed his sixth and final expedition to the Lindenmuir site in northern Colorado, work which has added greatly to our knowledge of Folsom man and the early occupation of America. The work of the International Exchange Service was seriously hampered by world conditions, but scientific and other publications which cannot now be sent are being stored until the end of hostilities.

Meteorology in Art

MR. L. C. W. BONACINA's paper on the "Scenic Approach to Meteorology" (*Quart. J. Roy. Meteor. Soc.*, Oct., 1941), his fifth essay on the landscape-impression of weather, is a valuable contribution to that co-operation between science and art which is so important for the development of human personality. Truth and beauty, long kept in separate compartments of the mind, are now being welded together, a task in which Mr. Bonacina is a diligent and gifted worker. The papers of 1937–38 contain analyses of the paintings of Constable and Turner; that of 1939 carries on the subject to the treatment of landscape-meteorology by men of letters, and those of 1940–41 deal with the pictorial relation of atmosphere and the landscape background as seen by the author. In these descriptions there is a power of expression which enables the reader to share that faculty of observation with which the writer is endowed. Development of the æsthetic appreciation of Nature is especially valuable at the present time. At long last it is beginning to be realized that beauty should take an equal place with truth and goodness in that trinity of enduring values which is needed to fortify the mind during the stress and strain of war.

Rainbow Bridge over the Niagara Falls

THE approaching completion of the Rainbow Bridge at Niagara Falls, is a happy augury of that closer co-operation between the United States and Canada which has been intensified by the present state of world relations. The bridge was built under the auspices of an international body, the Niagara Falls Bridge Commission, consisting of eight members, four having been appointed by the Governor of New York and four by the Lieutenant-Governor of Ontario. The project has been financed by a bond issue of four million dollars.

The previous bridge at the same place, the correct name of which was the Falls View Bridge, was built in 1895. This was an arch structure which stood until January 27, 1938. On that day an ice jam which had formed in the gorge rose to an unprecedented height, and crushed the end portions of the arch ribs, causing a complete collapse of the bridge. The Falls View Bridge was the property of the International Railway Company, which after its destruction immediately prepared plans for a new structure. Public opinion, however, opposed the construction of another privately owned toll-bridge at this site and as a result the Company did not proceed with the plans for rebuilding. The Niagara River at the Bridge site flows through a gorge approximately 1,250 ft. wide and 180 ft. deep from the surface of the water to the top of the cliffs. The river is about 830 ft. wide and 175 ft. deep, and the flow is 25–30 m.p.h.

Demonstration of the Circulation by Experiment

IN a recent paper (*Isis*, 33, 443; 1941) entitled "The Significance of the Demonstration of the Harveyan Circulation by Experimental Tests" Dr. H. P. Bayon raises the question already put forward by Sarton in 1937 as to why the discovery of the circulation of the blood was completed by an English physician and why its acceptance was delayed until the middle of the seventeenth century. Galen's erroneous doctrine of the to-and-fro movement of the blood which was accepted for so long a period was based on the belief that the anatomical features of the heart, uterus and liver in the dog or pig must also be present in man. According to Dr. Bayon, the delay in the acceptance of Harvey's discovery of the circulation until the middle of the seventeenth century was due to the fact that it was not until then that accurate comparative anatomical observations became available through woodcuts, printed works and dissection. It was by the intelligent use of the experimental method that Harvey was able to test and control his interpretation of clinical observation and comparative anatomy. His investigations were completed by the discovery of the capillaries, which formed the missing link between the arteries and veins.

Golf Courses during War-time

VOL. 6 of the *Journal of the Board of Greenkeeping Research*, which has just been published, shows that the Research Station at Bingley is adapting itself most successfully to the new problems which are confronting golf clubs owing to the War. Land is being ploughed up on many courses, hay and silage crops are being taken from others and sheep-grazing is widespread. In consequence, the erection of adequate fencing has become a major problem. Trials are described which show that electrified fencing is likely to prove a simple and effective method of control, while at the same time it gives a cash saving of 80–90 per cent over the ordinary post and wire type. Methods for making silage from grass mowings have been investigated with very satisfactory results. Information is supplied as to how the grass can be collected, the type of silos to use and precisely how they should be filled. Young grass mowings are so nutritious that a really valuable contribution to the country's feeding-stuffs could be made in this way. If silage-making is not practicable, the grass mowings need not be wasted, but can be either composted for manure or dried for cattle feeding. An appeal is made to former subscribers for their continued support, as this is essential if the Research Station is to be in a position to fulfil its normal functions directly the War is over.

Certificate in Natural History

A new edition of the emergency regulations for the certificate of proficiency in natural history has just been issued by the University of London. The work, which has been specially designed to take advantage of the fact that large numbers of teachers are, owing to war conditions, presented with a unique opportunity of natural history study in the field, involves a directed course of private reading at home, attendance at a practical laboratory course of two weeks duration in the summer vacation, an approved plan of field-work suited to the student's locality to be written up in the form of an essay, and examination. Definite arrangements have not yet been made, but it is hoped that the practical course this year will be held at the Royal Holloway College, Englefield Green, Surrey, during July 26–August 8. Copies of the regulations and further information may be obtained from the University Extension Registrar, University of London, at Richmond College, Richmond, Surrey.

Diagrams and Formulæ for Lantern Slides

Prof. A. C. Chibnall, of the Imperial College of Science and Technology, London, has utilized 'Cellophane' and 'carbon' paper for the preparation, without photography, of lantern slides of line diagrams and chemical formulæ. Mr. J. W. Minnis, of the Chemistry Department, Heriot-Watt College, Edinburgh, states that he has obtained good results with two lantern-slide cover-glasses. A piece of typewriter 'carbon' paper is placed on one and the required diagrams or formulæ are drawn on the back of the 'carbon' paper, using a glass rod pulled to a point. The paper is removed, the second cover-glass placed over the carbon image, and the two glasses bound together in the usual manner. The resulting slide gave good reproduction in the lantern.

Synthetic Rubber Production in Canada

Mr. Howe, the Dominions Minister of Munitions, has announced the establishment of a Government-owned company called the Polymer Corporation, Ltd., with headquarters in Toronto, which will undertake the production in Canada of synthetic rubber of the Buna type. According to the Ottawa correspondent of *The Times*, Mr. Howe said that four plants would probably be required for the three stages of the manufacturing process to be employed. The output, when the plants are working at full capacity, is expected to be about 34,000 tons a year, but production cannot begin before the end of 1943. Colonel Arthur L. Bishop, a prominent Toronto industrialist, has been appointed president of the Corporation, and there are four other directors.

Announcements

Mr. R. A. Butler, president of the Board of Education, is to be chairman of the Scientific Advisory and Engineering Advisory Committees in succession to Lord Hankey.

Sir John Greenly was elected president for 1942–43 of the Institute of Metals at the annual general meeting held on March 11.

The Committee of the Athenæum has elected the following gentlemen, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature, or the arts, or for their public services: Prof. P. M. S. Blackett, Langworthy professor of physics, University of Manchester; Mr. T. D. Kendrick, keeper of British and Mediæval Antiquities, British Museum; Mr. J. M. Keynes, economist, and fellow and bursar of King's College, Cambridge.

The following appointments in the Colonial Service have recently been made: S. R. Payne, assistant conservator of forests, Gold Coast; C. B. Garnett (senior agricultural officer, Zanzibar), senior agricultural officer, Nyasaland.

The conference on "European Agriculture: Scientific Problems in Post-war Reconstruction", arranged by the Division for the Social and International Relations of Science of the British Association, and postponed from March 13–14 owing to the death of Sir William Bragg, will be held on March 20–21 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, with sessions at 10.15 a.m. and 2.15 p.m. on each day as previously arranged, and the programme, so far as possible, unaltered. Fresh tickets will not be issued.

The Science Faculty of the Marx Memorial Library and Workers' School has arranged symposia on "Science and Technology in the Soviet Union" and the "Scientific Attitude to Fascism, with particular reference to Racial Theories", to be held at the London School of Hygiene and Tropical Medicine on April 5 and 6. Papers at the first symposium will include those by Prof. J. D. Bernal, Mr. Eric Godfrey, Dr. Norman Henry, Mrs. B. King, Dr. J. Needham, Mr. H. Rose, Dr. M. Ruhemann and Mr. H. P. Vowles. Those for the second symposium include the following authors: Prof. J. B. S. Haldane, Dr. C. F. D. Hawkes, Dr. P. Gorer, Prof. H. Levy, Dr. G. M. Morant and Mrs. Dona Torr. Further information can be obtained from the secretary, Faculty of Science, Marx House, Clerkenwell Green, London, E.C.1.

Errata. The May Lecture of the Institute of Metals is to be delivered on May 13, not May 31 as stated in Nature of March 14, p. 299.

In Nature of February 28, p. 243, under "Night Sky in March" the word "occultations" of the planets was inadvertently used for "conjunctions".

LETTERS TO THE EDITORS

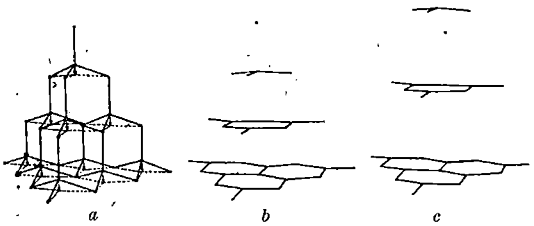
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Structure of Carbon

ATTENTION has been directed by Taylor and Laidler[1] to the appearance of 'extra' lines on X-ray photographs of graphite. These lines are given by several quite unrelated specimens and they do not seem to be connected with impurities. Finch and Wilman[2] and Taylor and Laidler[1] tried to interpret them as secondary diffraction phenomena of the graphite structure, but without producing any convincing evidence for their theories[3]. We find, however, that the lines may be explained by the presence of about 10 per cent of another structure that is closely related to graphite, and this therefore implies that carbon can exist in three different crystalline forms.

The new structure may be described in the following way. Ordinary graphite is composed of layers of carbon atoms arranged in hexagonal rings; these layers are so disposed that alternate atoms lie directly over other atoms and centres of hexagons respectively in the layer below. There are three different layers that can be built together to satisfy this condition; graphite uses two of them alternately; the new structure uses the three in sequence. Thus its unit cell has a c-axis $\frac{3}{2}$ times as long as that of ordinary graphite, in agreement with Finch and Wilman's observation that many of the lines may be indexed on the basis of the ordinary unit cell if the fractional l indexes $\frac{1}{3}$ and $\frac{2}{3}$ are allowed.

Although the structure may be referred to hexagonal axes, it is really rhombohedral, the basal symmetry plane of the graphite structure being replaced by centres of inversion, so that the alternating six-fold symmetry is lost. The simplest description of the structure is that it belongs to the space-group $R\bar{3}m$, ($a = 3{\cdot}635$ A., $\alpha = 39{\cdot}49°$) and has atoms at $\pm(\frac{1}{6}, \frac{1}{6}, \frac{1}{6})$.



a. Diamond ⟶ *α*-pseudo-graphite structure.
b. *α*-pseudo-graphite structure.
c. *β*-pseudo-graphite structure.

The structure, although closely resembling graphite, is similar to diamond in the arrangement of its planes; but in diamond the planes are puckered and closer together. Nath[4], in a theoretical study of the transition from diamond to graphite, has suggested that there is an intermediate structure formed, and it is interesting that this structure is exactly that described here. The accompanying figure is reproduced from his paper. It shows the diamond structure (*a*), an intermediate structure which has not been observed (*b*), and the new structure (*c*). There is, however, no explanation of the apparent existence in equilibrium of the two structures.

The experimental evidence on which we base these results will be described elsewhere.

We wish to thank Dr. Taylor for the loan of one of his photographs, and Mr. H. P. Rooksby of the General Electric Company for specimens of Ceylon and Bavarian graphites.

H. LIPSON.
A. R. STOKES.

Cavendish Laboratory,
Cambridge.
Feb. 20.

[1] Taylor and Laidler, NATURE, **146**, 130 (1940).
[2] Finch and Wilman, *Proc. Roy. Soc.*, A, **155**, 345 (1936).
[3] Lonsdale, K., Knaggs, I. E., and Smith, H., NATURE, **146**, 332 (1940).
[4] Nath, N., *Proc. Ind. Acad. Sci.*, **2**, 143 (1935).

Purification of Penicillin

PENICILLIN has been obtained in the form of a highly purified barium salt by repeated fractional extraction from amyl acetate into water, chromatographic separation on an alumina column, treatment of the active fraction with aluminium amalgam and further repeated chromatographic separation until the alumina column appeared homogeneous. The preparation thus obtained, though not crystalline, has an activity of 450–500 Oxford penicillin units per mgm., corresponding to a complete inhibition of the growth of *Staphylococcus aureus* in broth in a dilution of 1 : 25,000,000. Penicillin must therefore be regarded as one of the most powerful antibacterial substances with predominantly bacteriostatic action known.

Details of the method of purification and an account of some chemical, physical and biological properties of penicillin will be published shortly.

E. P. ABRAHAM.
E. CHAIN.

Sir William Dunn School of Pathology,
University of Oxford.
Jan. 31.

Further Observations on the Increased Yield of Nucleic Acid from Irradiated Yeast*

DURING the course of investigations intended to extend previously reported observations[1] of increased yields of nucleic-acid-like substances from yeast irradiated with full ultra-violet radiation under conditions resulting in prolonged injury to the yeast cells, certain irregularities in the yields were noted. It now appears that these may be attributed to lack of quantitative yields in the final step of the chemical procedure wherein nucleic acid is precipitated.

As in the previous experiments[1], starch-free yeast (*S. cerevisiæ*, Fleishmann bakers' strain) was employed at a concentration of 300 gm. wet weight to each litre of suspension medium. Each suspension was divided into two equal portions. One was irradiated with full ultra-violet light from a quartz mercury arc. The other, which served as a control, was not irradiated but was subjected to the same conditions of stirring. Because of rise in temperature of the irradiated suspension above that of the control in certain of the experiments in which an air-cooled arc was used, a Kromayer water-cooled arc was substituted in other experiments. With it, the energy was insufficient to obtain an appreciable degree of killing (methylene blue test) during the period of irradiation (10–22 hr.). Subsequent to irradiation, nucleic acid was prepared from the control and irradiated suspensions by the method of Johnson and Harkins[2].

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In all, six preparations were carried through chemically, but spectrographic data, forming the basis of this report, are available for only four of these. Table 1 shows the yields in terms of dry weights of the precipitates obtained by the Johnson and Harkins procedure. It will be noted that there was no correlation between the extent of injury and the yield of nucleic acid, and that in two of the four instances yields were actually much less from irradiated than from non-irradiated yeast. However, various irregularities in the final precipitations were noted; for example, the formation of suspensions of very fine particles in some instances (which were precipitated with difficulty) as contrasted with the formation of large, flocculent, easily precipitable particles in other instances. This suggested that an appreciable proportion of the nucleic acid might remain in solution in the supernatants after precipitation.

TABLE 1. WEIGHTS OF PRECIPITATES OBTAINED IN THE PREPARATION OF NUCLEIC ACID FROM IRRADIATED AND NON-IRRADIATED YEAST.

Preparation	U.V. Source	Suspensions medium	Time of irradiation, hr.	Extent of killing, per cent	Yield of nucleic acid per 100 gm. wet wt. of yeast	
					Non-irrad.	irrad.
5.2.41	Air-cooled	Reader's[3]	10	*ca.* 30	1·60 gm.	1·90gm.
7.17.41	Water-cooled	Reader's	22	negligible	1·73	1·83
7.23.41	Water-cooled	Isotonic saline	19	*ca.* 5	1·19	0·89
8.4.41	Water-cooled followed by air-cooled	Reader's	*ca.* 24	*ca.* 98	0·96	0·73

In order to determine whether this could account for the irregularities, ultra-violet absorption spectra were taken of the final supernatants from both irradiated and non-irradiated yeast. These showed, in every instance, the typical absorption spectra of nucleic acids (marked maximum near 2600 A., etc.)[4]. Quantitative determinations were then made of the amounts of nucleic acid (or nucleic-acid-like materials) remaining in the supernatants, employing the value 25·0 for the extinction coefficient of yeast nucleic acid in terms of gm. per litre concentration and cm. cell thickness[5]. The results of these determinations are shown in Table 2. These results indicate that in five instances out of eight, the amount of nucleic-acid-like material remaining in the supernatants was actually greater than that precipitated.

When the yields of the precipitates were added to the amounts remaining in the supernatants (Table 3), the total yields were in each instance greater for irradiated than for non-irradiated yeast. In the two instances (second and third preparations) in which the irradiation conditions were such as to result in only slightly lethal effects on the cells, the increased total yields were small. In the case of the 7.17 preparation, the total increase observed was within the limits of experimental error. In the case of the 8.4 preparation, however, in which the conditions were such as eventually to kill almost all of the cells, the total yield from irradiated yeast was almost twice that from non-irradiated yeast.

TABLE 2. NUCLEIC ACID REMAINING IN SUPERNATANTS AFTER REMOVAL OF PRECIPITATES, GM. PER 100 GM. MOIST YEAST.

Preparation	Non-irradiated	Irradiated
5.2.41	1·66	1·80
7.17.41	0·97	0·93
7.23.41	1·35	1·89
8.4.41	1·11	3·24

TABLE 3. TOTAL YIELDS OF NUCLEIC ACID IN PRECIPITATES AND SUPERNATANTS, GM. PER 100 GM. WET WEIGHT OF YEAST.

Preparation	Precipitate only			Total, precipitate and supernatant		
	Non-irradiated	Irradiated	Per cent increase or decrease	Non-irradiated	Irradiated	Per cent increase or decrease
5.2.41	1·60	1·90	+18·8	3·28	3·70	+13·5
7.17.41	1·73	1·83	+ 5·8	2·70	2·76	+ 2·2
7.23.41	1·19	0·89	−25·2	2·54	2·78	+ 9·4
8.4.41	0·96	0·73	−24·0	2·07	3·97	+91·8

These data demonstrated the lack of reliability of chemical precipitations alone in estimating the quantities of nucleic-acid-like substances present in various preparations. They show also the value of the spectrographic technique as a quantitative evaluation of the reliability of the chemical procedures.

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[1] Loofbourow, Englert and Dwyer, NATURE, 148, 113 (1941).
[2] Johnson and Harkins, *J. Amer. Chem. Soc.*, 51, 1784 (1929).
[3] Reader, *Biochem. J.*, 21, 901 (1927).
[4] Heyroth and Loofbourow, *J. Amer. Chem. Soc.*, 53, 3441 (1931).
[5] Heyroth and Loofbourow, *Bull. Bas. Sci. Res.*, 3, 237 (1931).

Acute Inhibition of the Corpus Luteum Excited by the Onset of Anœstrus in Elephantulus

OVER several years we have accumulated extensive material of serially sectioned ovaries and uteri of *Elephantulus myurus jamesoni*. From an examination of the ovaries it is now possible to identify accurately the physiological state of the animal in respect of its menstrual or reproductive cycle.

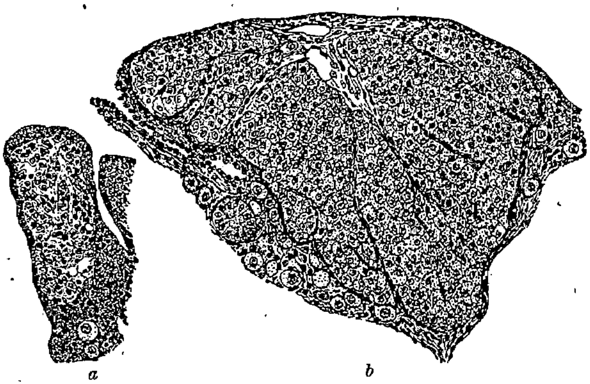
Elephantulus is a primitive mammal usually included among the Insectivora, but this mammal may turn out to be an important link between the Insectivores and the Primates.

Attention has already been directed to the extraordinary reactions shown in the ovary during ovulation[1] and in the uterus throughout the menstrual cycle[2]. In our most recent investigation we have correlated the post-ovulatory changes in the uterus with the structure of the corpus luteum[3].

Although not previously mentioned in our publications a third factor facilitates the identification of the stage in the cycle that an animal happens to be in after ovulation. This is the extent of decomposition of the numerous eggs[4] present in the uterus after ovulation.

Anœstrus in Elephantulus extends from March or April until the end of July or the beginning of August.

Recently in examining our series No. 428 of an animal killed in April 1939, we found that both the ovaries and uterus presented an appearance typical of anœstrus. To our surprise, however, we discovered degenerating eggs in the uterus. In an œstrous animal such eggs are normally associated with well-developed corpora lutea in the ovary and the stage of dense stroma in the uterus. On carefully re-examining the ovaries we discovered curious cellular bodies which were neither corpora lutea of the normal menstrual cycle nor corpora lutea of a remote or recent pregnancy (see accompanying illustrations).



TWO CORPORA LUTEA OF ELEPHANTULUS ASSOCIATED WITH EGGS IN THE UTERUS IN APPROXIMATELY THE SAME STAGE OF DEGENERATION.

(a) From an animal in early anœstrus; (b) from an animal in the menstrual cycle. (× 125.)

Obviously this animal ovulated just a little while before the precipitous onset of anœstrus inhibited the whole post-ovulatory process and the normal development of the corpora lutea.

From these facts we venture to conclude the following:

(a) Anœstrus inhibits the pituitary in respect of its gonadotropic hormones.

(b) The continued development of the menstrual corpus luteum after ovulation is dependent upon the presence of a gonadotropic hormone from the pituitary.

(c) This hormone maintaining lutein growth is acutely inhibited by the factor or factors responsible for anœstrus.

(d) The onset of anœstrus in any individual animal is a relatively acute process.

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Dec. 31.

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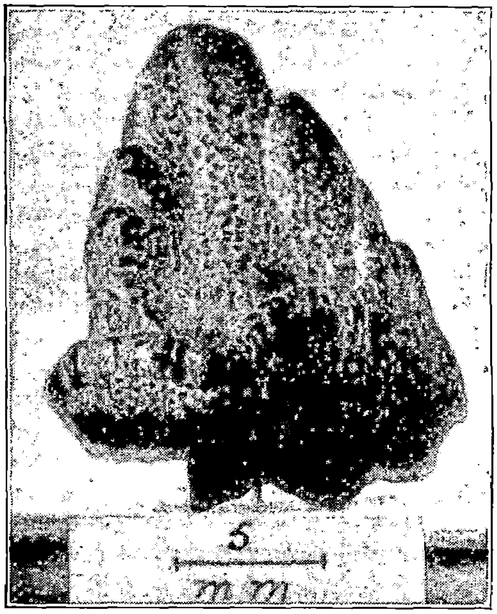
[1] *S. Afr. J. Med. Sci.*, **5**, 73 (1940).
[2] *S. Afr. J. Med. Sci.*, **6**, 27 (1941).
[3] *Anat. Rec.*, **80**, 443 (1941).
[4] *S. Afr. J. Med. Sci.*, **7** (in the press) (1942).

Anthracotheriidæ in Ceylon

IN 1941 a collection of fossils made by Mr. M. C. Wickremasekera from the Ratnapura beds near Kuruvita in Ceylon was sent to the Colombo Museum by Mr. D. N. Wadia, Government mineralogist. Examination revealed the premolar tooth of a member of the family Anthracotheriidæ of the order Ancodonta. Dr. E. H. Colbert, of the American Museum of Natural History, to whom sketches and photographs of the tooth were afterwards sent, agrees with my identification and this confirms a discovery of considerable importance to Ceylon geology. In the first article[1] describing mammalian fossils from Ceylon it was suggested that they were of late Pliocene or early Pleistocene age.

The subsequent discovery that remains of a race of the most recent member of the Proboscidea, namely, *Elephas maximus* Linné, occur with those of the hippopotamus, suggested that the Ceylon fossil beds are much younger, but the more advanced mineralization of the present discovery suggests that the age of these deposits dates back to the Pinjor or even farther. A feature of unusual interest is that in Ceylon fossils of anthracothere, hippopotamus, *Elephas maximus* and bovines occur in the gem-bearing bed which ranges in thickness between six inches and three feet, whereas in the Siwaliks the last of the Anthracotheriidæ occurs in association with the hippopotamus over a thickness of about seven thousand feet of fossiliferous beds, after which the hippopotamus survives alone in later beds which are about another three thousand feet thick. The Siwaliks are separated from Ceylon by nearly 25° of latitude and should the Ceylon tooth prove to belong to a local subspecies of *Merycopotamus dissimilis* (F. et C.) it will be of importance in correlating the fossil deposits of the Pinjor horizon of India, the Upper Irrawaddy beds of Burma, the Tji Djoelang horizon of Java, and the Ratnapura deposits of Ceylon.



The dimensions of the tooth are as follows: length of base 32 mm., width of base 18 mm., height above root 30 mm. The specimen was obtained from the debris at the mouth of a gem pit where the gem-bearing bed, which is usually also fossiliferous, lay at sixteen feet below the surface.

P. E. P. DERANIYAGALA.

Colombo Museum,
Ceylon. Jan. 1.

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[1] Deraniyagala, P. E. P., *Geol. Mag.*, **73**, 316 (1936).

Nitzschia Cultures at Hull and at Plymouth

MORE than thirty years ago a persistent culture of a minute diatom was obtained by Allen and Nelson[1]; they refer to it as *Nitzschia closterium*, W. Sm., *forma minutissima*. This persistent culture has been maintained at Plymouth ever since, and has been distributed to many workers at home and abroad. The species has proved to be a useful food for many kinds of marine larvæ and a convenient diatom for experimental work. A sample was sent to Hull about 1930 and has been grown there until the present time. When first sent the great majority of the frustules, as at Plymouth, were of the straight or slightly curved fusiform shape characteristic of the species, but in 1932 a very few three-rayed or tri-radiate cells were present; their abundance was certainly much less than 1 per cent. In cultures derived from Plymouth stock such cells have been seen by other workers, notably by Barker[2]. By 1934 there had, at Hull, been a slight increase in the abundance of these tri-radiates and they may have formed as much as 1 per cent of the cultures. In 1936 the proportion had risen to more than 50 per cent. Thereafter the abundance of tri-radiates steadily increased so that by the spring of 1939 they comprised 97 per cent, and by the summer of 1941 more than 99 per cent, of the cultures.

The Plymouth stock cultures first passed into the care of one of us late in 1937, from which time two strains have been kept. In 1939, when attention was specially directed to them, well over 90 per cent of the frustules were tri-radiate, indeed in one strain the culture was almost entirely tri-radiate. By June 1941 both strains were about 99 per cent tri-radiate. In 1939 two clone cultures of normal cells and one clone culture of tri-radiates were established, a sample of the latter—as well as of one of the former—being sent to Hull in February 1940 and maintained there by sub-culturing. All clone cultures for long remained almost true to type: after the first few months a very few cells of the alternate kind were to be seen; lately, there have been some significant changes. At Plymouth one clone normal (the clone normal not sent to Hull) has become about 5 per cent tri-radiate, but the other clone normal at Plymouth and at Hull is still almost pure. It is, however, to the tri-radiate cultures that attention is here directed.

The two strains of Plymouth stock and the clone, all three about 99 per cent tri-radiate in the preceding June, had by November 1941 produced large numbers of normal cells. There is little doubt from the appearance of the cultures that this was done by the gradual reduction and eventual elimination of one ray of the tri-radiate, for of the remaining tri-radiates a large proportion had one ray reduced. Another process by which normals may derive from tri-radiates is known but does not appear to have played any part in this particular change-over. The very remarkable feature is that while these changes were taking place at Plymouth almost identical changes were occurring in the cultures at Hull: until a short time ago neither author was aware of this fact. Even the percentages are now closely similar, as the following table shows. It is based on sub-cultures made at the end of November 1941 and counted recently when dense.

	Percentage tri-radiate	
	June 1941	February 1942
Plymouth Stock 569	99·3	61·6
,, ,, 589	98·6	64·7
,, clone tri-radiate	98·8	60·3
Hull Standard Stock	>99·0	62·0
,, General ,,		64·5
,, clone tri-radiate		68·25

The almost parallel recent history of these cultures, grown so far apart and differently treated as to time and frequency of sub-culturing, lighting, temperature, etc., is so striking that we are anxious to hear from anyone who, in the past ten years, has kept cultures of this diatom, especially if their cultures be derived originally from Plymouth stock. It is hoped to include in a paper to be published later any relevant observations other workers may be able to contribute.

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[1] Allen, E. J., and Nelson, E. W., *J. Mar. Biol. Assoc.*, **8**, 421 (1910).

[2] Barker, H. A., *Archiv Mikrobiol.*, **6**, 141 (1935).

Occurrence of a Halophilic Alga in Mid-Cheshire

ON October 26, while conducting some preliminary investigations in the course of an ecological survey of a salt-spring situated at Aldersey[1], seven miles south-south-east of Chester, the filamentous alga *Percursaria percursa* (formerly known as *Enteromorpha percursa* (Ag.)) was encountered. The presence of this alga is interesting because Percursaria is usually found in rock pools on the shore between tide marks. The only previous record of Percursaria from a brackish non-coastal region, which has come to my notice, is that mentioned by Grove[2] from brackish waters in the Midlands. The alga was evidently found in a ditch near the canal at Salwarp, Worcestershire. A note of this find is recorded by West and Fritsch[3]. The species is described and figured by Newton[4].

Percursaria percursa occurs in large masses at the Aldersey spring and is spreading into a neighbouring brackish gutter. The spring water, at the time the specimen was collected, had a salinity of 1,675 parts per 100,000 and a *p*H value of 7·0 (Lovibond comparator).

I gratefully acknowledge the assistance of Dr. Helen Blackler, of the Liverpool Museum, and Mr. E. G. Williams, of Chester, for their independent identifications of the alga.

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12 Queen's Road,
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March 3.

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[1] Sherlock, Mem. Geol. Survey, Mineral Resources of Gt. Brit. Rock-salt and Brine, **18**, 111 (1921).

[2] *J. Bot.*, **58**, 33 (1920).

[3] "British Freshwater Algæ", p. 162 (1927).

[4] Brit. Museum: Handbook of British Seaweeds (1931).

RESEARCH ITEMS

The Sargasso Sea

THE problem of the origin and extent of the weed in the Sargasso Sea, which has long been a debatable matter, is discussed by G. E. R. Deacon in a paper on the Sargasso Sea in the *Geographical Journal* of January. A century ago, Meyen argued that the weed grew as it drifted in the sea, that normal reproduction was vegetative and that the origin was in the Gulf of Mexico. Murray and Hjort did not subscribe to this theory; they believed that the weed would disappear if fresh supplies did not continually arrive from the coast. The weed certainly is not disappearing and there is not the least foundation for the statement of Tilden to that effect. It occurs in strips or patches, large and small, and is rarely out of sight in the whole area of the sea. Most of the weed belongs to two species, *Sargassum natans* and *S. fluitans*, but other forms are recognized. Mr. Deacon believes that there is little doubt that the weed is self-supporting, the total having been built up during centuries from plants drifted from the West Indies and by vegetative growth *in situ*. The annual contribution from the coasts is small. Evidence of vigorous vegetative growth, in leaves and branches free from Bryozoa, is abundant. Neither of the main forms, however, has been identified from the shores of the West Indies, but this does not preclude its original coastal origin. The absence of any field of weed on the coasts large enough to keep the Sargasso Sea as full as it is of weed shows that the weed must grow and multiply as it drifts, while the distribution of the currents is responsible for its accumulation and maintenance.

Excretion of Ammonia by Blowfly Larvæ

IN contrast with the vast majority of insects, which excrete the greater part of their nitrogenous waste in the form of uric acid and its salts, the larvæ of blowflies eliminate most of their waste nitrogen in the form of ammonia. This latter method of nitrogenous excretion results in a most economic procedure since it involves no loss of unburned carbon. Pamphlet No. 109 of the Council for Scientific and Industrial Research, Commonwealth of Australia, comprises two papers on the above subject by F. G. Lennox, the insect studied being *Lucilia cuprina*. In the first article, the rate and distribution of ammonia production form the main subject. It appears that practically all the ammonia produced in the mid-gut passes to the hind-gut via the Malpighian tubes. It does not reach its maximum until one or two days after the peak of larval growth. The second article is concerned with the enzymes responsible for ammonia production in the species named. Judging by the large quantity of ammonia liberated in the presence of adenosine, it is concluded that adenosine deaminase is probably an enzyme of major importance in blowfly larvæ. Deamination occurs chiefly in the midgut region where proteolysis can also be demonstrated. The few other insects known to excrete ammonia nitrogen include the larvæ of *L. sericata* (Hobson, 1931), and of *Calliphora vomitoria* (Wienland 1906). In order to establish the claim that the ammonia liberated by such larvæ is a product of their own metabolism and not of associated micro-organisms, the insects were reared from sterilized eggs in a sterile synthetic media. The details of the technique employed and the apparatus are fully described in the present pamphlet.

Rate of Growth and Timber Quality

L. P. V. JOHNSON, forest geneticist, National Research Laboratories, has reported the results of an examination of the effect of rate of growth upon timber quality carried out upon forty-three trees of hybrids and parents involving *Populus alba*, *P. grandidentata* and *P. tremuloides* (*Canadian J. Res.*, 20, 28; 1942). As these hybrids can usually be propagated readily by vegetative means and may have a rate of growth far in excess of their parents, the point is of great interest and the tentative conclusion—that rapid growth is not seriously detrimental to quality for paper pulp production—suggests great practical possibilities for these new hybrids. A short, thick habit of growth in these trees was found to be significantly correlated with high wood density, but correlation between growth-rate (in terms of annual increment of volume) and wood density was insignificant. In the same tree the fibres in wide annual rings were longer on the average than those in narrow rings—in the same annual ring the fibres of the early wood were shorter and thicker than those of the late wood. The last point recalls the observation of Priestley and Scott (*Proc. Leeds Phil. Soc.*, 3, 235; 1936) that the fibres among the vessels of the early wood of Fraxinus were shorter than those in the later wood.

Mechanism of Germination of Conidia of Erysiphe

THE mildews are characterized by a dispersal mechanism which seems to operate in relatively dry conditions and the conidia then seem to germinate and the infection to spread under low humidity conditions that would seem likely to militate against a mildew epidemic. Some very interesting observations and suggestions upon the subject appear in a paper by Harold J. Brodie and C. C. Neufeld of the Department of Botany, University of Manitoba (*Canadian J. Res.*, 20, 41; 1942). In *Erysiphe Polygoni* the conidium is cut off by a ring of wall material which forms from the periphery of the hypha inwards until a perforate disk is formed. Later, the pore in this disk is closed by a minute papilla by which alone the mature conidium remains attached until passively discharged. The wall of the conidium is relatively impermeable to water and stains enter only at the papillate end. This papilla thus seems to provide a permeable spot on the wall which is only exposed after detachment. The authors suggest that abstriction is thus followed by release of carbon dioxide and entry of oxygen through the papilla and that germination then starts even at low humidities. In support of this view they show that germination is checked in an atmosphere of nitrogen or in one containing 10 per cent carbon dioxide.

Volatile Reducing Substances in Vinegars

A STUDY of the volatile reducing substances in vinegar was reported by J. M. Whitmarsh to the Society of Public Analysts and Other Analytical Chemists on February 4. The Edwards and Nanji tests for oxidation and iodine values have been applied to a number of vinegars and the results compared with the results obtained by those authors. Estimations have been made of the amounts of various volatile reducing substances in vinegars and the presence of acetyl methyl carbinol in spirit vinegar has been demonstrated, contrary to several statements in the literature. The oxidation and iodine values of solutions of these volatile-reducing substances have been measured, and it is concluded that the distinctive values for spirit vinegar are due to its content of alcohol, and those for malt vinegar are due, largely if not entirely, to the presence of alcohol and acetyl methyl carbinol.

Equilibrium between Cuprous and Cupric Compounds

MANY cuprous compounds tend to decompose into cupric compounds and copper, and the chief controlling factor governing this instability has been shown by J. E. B. Randles (*J. Chem. Soc.*, 802; 1941) to be the degree of covalency or electrovalency of the bonding between the copper ions and neighbouring ions or molecules, which depends mainly on the polarizability of the latter. The transition from ionic to covalent type depends on a large decrease of ionic charge and so of electrostatic interaction. As the polarizability of the anions or molecules interacting with the copper ions increases, the interaction energy increases and the cuprous compound becomes more stable. The equilibrium between cuprous and cupric ions in presence of metallic copper was investigated with different compounds, and the results confirm the theoretical deductions.

Absorption Spectra of Unsaturated Ketones

THE absorption spectra of a number of β-unsaturated ketones have been examined by L. K. Evans and A. E. Gillam (*J. Chem. Soc.*, 815; 1941). Woodward (*J. Amer. Chem. Soc.*, **63**, 1123; 1941) has tabulated the wave-lengths of the absorption maxima of many ketones, and his data show that they fall into three classes according to the substitution of the C=C—C=O group, the locations of the intense absorption bands being as follows: monosubstitution (α or β), 2250 ± 50 A.; disubstitution (αβ or ββ), 2390 ± 50 A.; trisubstitution (αββ) ± 2540 ± 50A. The nature of the substitution of the chromophoric group in these compounds can thus be predicted from the location of the main absorption band. Evans and Gillam find that, with very few exceptions, this generalization is well obeyed, which increases the usefulness of absorption spectra in the elucidation of organic structure. The study of the effect of substituting simple αβ-unsaturated ketones with methyl groups showed that a larger bathochromic effect is produced by substitution on the β-carbon atom than by substitution on the α-carbon atom. Other types of compounds are also discussed in the paper.

Measurement of the Flow of Liquids and Gases

A USEFUL summary of methods used for measuring the flow of liquids and gases is given in a paper by E. Ower and the subsequent discussion (*Trans. Inst. Chem. Eng.*, 18, 87; 1940). The various types of instruments used are described and the methods of calculation discussed, and there is a short bibliography of recent literature.

Time Bases

O. S. PUCKLE, in a paper read before the Institution of Electrical Engineers on February 4, refers to the development of various types of time bases employing hard and soft valves, both for general- and special-purpose applications, the aim of the paper being to elucidate the principles involved rather than to describe the actual instruments in detail. Several little-known devices are described, and the highly important technique of producing and controlling pulses is considered. The results of recent investigations into some peculiarities of the gas-discharge triode are included, and presented in the form of an appendix.

Radial Velocity Curve of δ Cephei

INVESTIGATIONS of radial velocity curves of Cepheids have been published by Rufus and other Michigan observers, and these indicate the existence of marked relative displacements between spectral lines originating at different levels in the stellar atmosphere. These levels have been taken as equivalent to the heights of the same lines in the solar chromosphere. It is significant that Jacobsen and Mendenhall found no convincing evidence for the existence of relative displacements, and the same conclusion was reached by Petrie, who obtained about a hundred single-prism spectrograms of δ Cephei, using the same instrument as the earlier Michigan observers. H. A. Brück and H. E. Green have now discussed this subject (*Mon. Not. Roy. Astro. Soc.*, **101**, 8). They have made use of a number of four-prism spectrograms of δ Cephei which had been secured with the Newall 25-in. refractor of the Solar Physics Observatory, Cambridge, and which had been originally used for a spectrophotometric study of line intensities and their variations during the cycle. These spectrograms have a dispersion of 13 A./mm. near $H\gamma$ and are in good focus over a wave-length region extending from λ 4250 to λ 4650. The negative results of Petrie and Jacobsen were confirmed, no definite relative displacements between lines of different atmospheric levels being detected. It is possible that small differences between the velocity curves of groups of neutral iron and ionized titanium lines exist, and there is some evidence for relative shifts in the case of the neutral-calcium line λ 4425·6.

Solar Parallax and Mass of the Moon

THE Astronomer Royal has published a paper on "The Solar Parallax and the Mass of the Moon from Observations of Eros at the Opposition of 1931" (*Mon. Not. Roy. Astro. Soc.*, 101, 8); this is a summary of his complete results (*Mem. Roy. Astro. Soc.*, 66, Part 2). Independent determinations from observations of R.A. and Declination are in good agreement and the value adopted for the solar parallax is 8·7904″ ± 0·0010″. The probable error which has been assigned to the final value of the solar parallax is based on the high internal accordance of the results, and the question arises regarding a possible systematic source of error due to differential atmospheric dispersion. A discussion of this problem shows that the effects of colour differences between Eros and the reference stars tend to assume a random nature and the general effect is small. A description of the procedure adopted for the determination of the constant of the lunar equation is given, and the value derived from the Eros observations is 6·4390″ ± 0·0015″, and from this and the solar parallax the reciprocal of the mass of the moon is 81·271″ ± 0·021″. From this value and that of the constant of precession, 5493·156″, the computed value of the constant of nutation is 9·2266″ ± 0·0008″; this is much larger than the adopted value, 9·210″. An unexplained discordance has existed between the observed value of the constant of nutation and the value inferred from the observed values of the constant of precession and the mass of the moon, and it is remarkable that the new value of the mass of the moon has increased this discrepancy. It is highly desirable that an accurate value of the constant of nutation should be determined from observations specially planned for the purpose.

CHEMOTHERAPEUTICAL USE OF HALOGENIZED PHENOLS AS EXTERNAL DISINFECTANTS

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FOLLOWING the detection of large quantities of œstrogenic hormone in pregnant mare urine[1], we have observed that mare urine remains for months without decomposing. Germs inoculated in long-standing urine did not multiply. The disinfecting action of horse urine is due to phenol bodies present in it (1 gm. per litre). Human urine contains 100–150 mgm. free phenol per litre urine and 150–250 mgm. combined phenol.

The fact that large quantities of phenol are eliminated in the urine encouraged us to study the chemotherapeutic use of the phenol bodies in human beings, in spite of the fact that Robert Koch and Paul Ehrlich had pointed out in their classical studies on this subject that no internal disinfection is possible by means of external disinfectants. Bechhold and Paul Ehrlich[2] ascribed the failure of this method to the fact that the halogenized phenols studied by them (tetra-bromo-*o*-cresol, hexa-bromo-di-oxy-diphenyl-carbinol, etc.), although not causing precipitation, developed only a limited activity in serum.

In the following a brief account is given of our investigations, as a result of which it became apparent that the external disinfectants—the halogenized phenols were studied—were able to effect internal disinfection. For therapeutic use a phenol body had to be chosen which, although harmless to the organism, would have a high disinfective potency. Most promising in this respect seemed a mono-halogen-phenol containing various methyl groups. Halogenized xylenol, a substance which has been employed for many decades as an external disinfectant[3], was found most suitable. It is also a halogenized xylenol that constitutes the basic principle of 'Dettol', which is much used in England as an effective disinfectant for the surgeon's hands as well as for the genital region in obstetrics[4].

In our experiments we used mostly *p*-chloro-xylenol (1, 3-methyl, 5-oxy, 2-chloro-benzene), briefly referred to here as *CX*. We also studied the chemotherapeutic action of several esters and ethers of *CX* (sodium sulphate ester, acetate ester, benzoate ester, ethyl ether, methyl ether). Furthermore, we examined *ortho-iso*-propyl-*CX* and *sec.-iso-amyl-CX*.

The disinfective action of *CX* *in vitro* was found to be 25–30 times as strong as phenol[5]. In several experiments we found that *CX* is able to destroy typhoid germs as well as proteus or *B. coli* in dilutions of 1 in 10,000 and staphylococci in dilutions of 1 in 20,000 within 60 minutes.

In contrast to the results of Paul Ehrlich's experiments, we found that *CX* exercises a protective effect *in vivo*. Although it was not possible to save mice infected with streptococci, the experiments gave positive results when rats were infected with pneumococci. It was only in some of these experiments that we succeeded in saving the rats from this deadly pneumococcal infection. Parallel experiments with sulphapyridine gave similar results.

A colorimetric method for the quantitative determination of *CX* in the urine and blood of animals and men was elaborated in co-operation with Dr. Benyamin Shapiro. This method will be described elsewhere.

An oily solution of 10 per cent *CX* was found most suitable for parenteral application in man. Good results were also obtained with a mixture of *CX* and *CX*-benzoate, 10 c.c. of which contained 2 gm. of the active substance. These preparations had to be injected deep intragluteally. The disadvantage of the parenteral route of administration is the occasional occurrence of painful infiltrations.

Following observation made in 1929[6], that œstrogenic hormone, which is also a phenol body, is absorbed by the skin, we have also studied the behaviour of halogenized phenol in this respect. The quantities of *CX* excreted during five days after injection of 1 gm. *CX* intramuscularly in a rabbit and after rubbing in 1 gm. *CX* in the form of an ointment on the shaved back of a rabbit were found to be the same, approximately 15 per cent. It thus follows that *CX* is absorbed through the skin, circulates in the blood and is excreted with the urine.

Percutaneous application in man in the form of a 30 per cent *CX* ointment never causes any secondary effects and may be given in large doses (10–20 gm. of the active substance a day). The following observations indicate that both the parenteral as well as the percutaneous application of *CX* in man has a chemotherapeutic effect:

(*a*) After administration of small doses the urine excreted remains sterile for many weeks. In this respect *CX* is more than seven times as active as sulphanilamide and six times as active as sulphapyridine. The total elimination of free *CX* amounts to 2–8 per cent, its excretion being greater in alkaline urine as compared with acid urine. It is thus advisable to give sodium bicarbonate and sodium lactate, before treatment with *CX*, so as to obtain an alkaline urine (*p*H 7·5–8·5). In human urine 31 per cent of the *CX* administered is eliminated in a combined form; 14 per cent is combined with glycuronic acid and 17 per cent with sulphuric acid.

(*b*) Twenty-four hours after inoculation of 5–50 staphylococci in 2 c.c. of defibrinated blood, 100–800 million staphylococci may be counted. When the blood of *CX*-treated patients is used for the same experiment, the multiplication of these organisms is hindered, making any count impossible; nevertheless, the organisms are not all destroyed, since on further passage of this blood to blood agar, staphylococci do grow. This powerful bacteriostatic effect is possible after the intramuscular or percutaneous application of only 2·5 gm. *CX*. So far as the bacteriostatic activity in the blood is concerned, the treatment with *CX* is far more effective than with sulphanilamide and more active than with sulphapyridine and sulphathiazole. The antibacterial action of *CX* in blood has so far been tested against staphylococci only.

(*c*) While organisms inoculated in the contents of cantharide blisters of normal men multiply rapidly, strong antibacterial effects are possessed by the same in *CX*-treated patients. This is an indication that *CX* penetrates the body tissues.

So far as the mechanism of action of *CX* is concerned, we found the following. Bouillon containing 100 mgm. *CX* per litre will destroy inoculated staphylococci. In order to obtain a similar effect with serum, 5–10 times higher doses of *CX* must be added. This is in conformity with Paul Ehrlich's experiments, in which serum was found to hinder the activity of halogenized phenols. From our experiments it is apparent that this inhibitory effect is due to proteins, since after addition of serum-protein to bouillon, higher amounts of *CX* were needed to inhibit the growth of bacteria, as compared with clear bouillon. After treatment with *CX*, it is the whole blood and not the serum that possesses antibacterial properties. We may thus conclude that *CX*, or a substance derived from it, attaches itself o the red blood corpuscles. The blood bactericidity of *CX*, which was examined in 500 cases, begins after 24 hours, at a time when no *CX*, or only a small amount of it, is present in the blood. We may thus assume that the active antibacterial substance is formed in the blood and is possibly not identical with *CX*. The bactericidal substance is bound to the red blood corpuscles since bactericidity disappeared once the erythrocytes hæmolized.

The clinical results obtained with *CX* will be reported in detail elsewhere. Here we may briefly note the following. The percutaneous application of 15 per cent *CX* ointment is an excellent means for he disinfection of the operative field, the skin remaining sterile for 12 hours. By the percutaneous application of 3 gm. *CX*, an antibacterial activity of he blood is simultaneously provoked, thus providing some protection against possible post-operative nfection. Since this anti-bacterial effect lasts for 24–48 hours, a further application of *CX* is advisable. The same is true of its use in obstetrics. In these cases at least 3 gm. of the active substance must be rubbed in the vulva, in order to combine the disinfection of the external genital organs with an antibacterial effect in the blood.

We have obtained most encouraging results in the treatment of urogenic infections (cystitis, pyelitis). Infections due to staphylococci and proteus react particularly well, and a disinfection of the urine is obtained. Infections due to *B. coli* react clinically well, that is, the symptoms disappear after a short time, but in most cases the *B. coli* are not destroyed, a bacteriostatic effect thus being obtained. The treatment lasts five days, the daily dose of *CX* amounts to 10–20 gm., which is given percutaneously with 1–2 gm. parenterally.

Up to now we have treated seven cases of puerperal septic infections. In two cases of streptococcal pyæmia, the treatment failed to give good results. In the other five cases the patients recovered. These ncluded two cases of staphylococcal pyæmia. In septic general infections the treatment—mostly percutaneous—should last at least fourteen days. Our experience in the treatment of other infectious diseases is still limited.

It should be especially emphasized that treatment with halogenized phenols in man is harmless and causes no secondary effects.

Zondek, B., *Klin. Wschr.*, **9**, 2285 (1930).

Bechhold, H., and Ehrlich, P., *Z. phys. Chem.*, **47**, 173 (1906).

Schottelius, M., *Münch. Med. Wschr.*, **59**, No. 49 (1912); Raschig, F., *Z. angew. Chem. Ztbl. tech. Chem.*, **38**, 1939 (1912).

Colebrook, L., *J. Obst. and Gyn. British Emp.*, **40**, No. 6 (1933); *Brit. Med. J.*, 723 (1933).

Klarmann, E., Shternov, V. A., and Gates, L. W., *J. Amer. Chem. Soc.*, **55**, 2576 (1933); Lockemann, G., and Kunzmann, Th., *Angew. Chem.*, **46**, 296 (1933): *Ztbl. Bakteriol.*, I, **145**, 61 (1933).

Zondek, B., *Klin. Wschr.*, **8**, 2229 (1929); *Schweiz. med. Wschr.*, No. 49 (1935).

FOLK-LORE OF ERUPTIVE FEVERS

AT a meeting of the Section of the History of Medicine of the Royal Society of Medicine on February 4, Dr. J. D. Rolleston read a paper on the folk-lore of eruptive fevers, in which he said that during the last two Congresses of the International Society of the History of Medicine held at Madrid in 1935 and at Zagreb and Belgrade in 1938, medical folk-lore formed a considerable part of the proceedings. In contrast with some diseases, particularly whooping-cough, pulmonary tuberculosis, skin diseases, especially warts, and eye diseases, the folk-lore of the eruptive fevers is somewhat scanty.

The abundance of folk-lore connected with each exanthem appears to be directly related to the antiquity and importance of the disease, so that the amount of folk-lore of smallpox, measles, scarlet fever and chicken-pox is represented in the order named. There does not seem to be any folk-lore connected with German measles, which did not receive general recognition as an independent disease until after the International Congress of Medicine held in London in 1881.

As regards the causation of the acute eruptive fevers there do not appear to be any popular causes for their occurrence, such as catching colds, sexual excess, or punishment for an evil life, as in the case of pulmonary tuberculosis, skin diseases and venereal diseases. With the exception of smallpox, none of them has been assigned a divine origin. In accordance with medical folk-lore generally, prophylaxis was rarely employed in the acute exanthemata except smallpox. There were many examples of the same treatment being applied to the eruptive fevers generally, such as overheating the patient or flagellation with nettles with the object of bringing out the rash, the use of red blankets and bed-hangings and coprotherapy.

As regards the causation of smallpox, numerous examples were given by Sir James Frazer and others of outbreaks of smallpox in different parts of the world being attributed to a goddess or, much more rarely, to a god, and of the various means employed to win their favour or prevent their visitation. Examples were also given of the avoidance of calling the deity or the disease by its proper name and using instead some more or less euphemistic words or phrases. The supposed transfer of smallpox to animals, plants and inanimate objects in accordance with folk-lore practice in other diseases was also described. Prophylaxis of smallpox by inoculation was a folk-lore method carried out by old women in Turkey long before it was adopted by the medical profession in Great Britain and France. Besides overheating the patient, the folk-lore treatment of smallpox consisted mainly of animal and plant remedies and the invocation of patron saints.

There are more popular errors concerned with measles than with any of the other acute exanthemata, such as the belief that it is a trivial disease, that it cleans out the system and makes the child less liable to contract other diseases, and that patients should not be washed, owing to the delusion that such an act tended to drive the rash inwards. In none of the acute exanthemata is coprotherapy more frequently employed than in measles, especially in the early stage of the disease. There were several examples of the belief that measles could be best treated by transfer of the disease to animals and plants, and apart from any idea of transfer numerous folk-lore remedies were supplied by animals, plants and minerals.

Doubtless owing to scarlet fever having been isolated as an independent disease much later than smallpox or measles, its folk-lore is much less than that of the other two diseases. Popular errors connected with it included the view that the term 'scarlatina' meant a mild form of the disease, that second attacks did not occur, and that a mild attack could transmit only a mild attack to another person. Instances are occasionally met with in which scarlet fever was supposed to be transferred to animals, such as a dog, bear or sheep. Amulets were sometimes worn for prevention of the disease. There does not appear to be any patron saint connected with scarlet fever as in smallpox or measles.

Although chicken-pox is probably as old as smallpox, owing to its usually mild character and uncomplicated recovery very little folk-lore is connected with this exanthem, but it has had a large number of popular synonyms which are out of proportion to its real significance. The term 'chicken-pox' was first used in medical literature in 1694 by Richard Morton, who spoke of a form of smallpox "called in the vernacular the Chicken-Pox". Fuller also in 1730, in a paragraph in his "Exanthematologia", wrote: "I have adventur'd to think that this is that which among our women goeth by the name of Chicken-pox."

Another example of folk-lore anticipating scientific medicine is furnished by the fact recently mentioned by W. N. Pickles that the connexion between herpes zoster and chicken-pox was known at Aysgarth in Yorkshire long before this connexion was demonstrated by Bokay in 1892.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Friday, March 20—Saturday, March 21

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (DIVISION FOR THE SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1).—Conference on "European Agriculture: Scientific Problems in Post-War Reconstruction".

Friday, March 20

10.15 a.m.—"Measures for Reconstruction". (Chairman: Sir John Russell, F.R.S.)

2.15 p.m.—"Economic and Kindred Problems". (Chairman: Mr. F. L. McDougall.)

Saturday, March 21

10.15 a.m.—"The Future Betterment of European Farming". (Chairman: Dr. A. J. Drexel Biddle.)

2.15 p.m.—(Chairman: Sir John Russell, F.R.S.)

Monday, March 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. H. P. Rooksby: "X-Ray Technique in the Industrial Laboratory". (Cantor Lecture, 2; Subsequent lecture on March 30.)

ROYAL GEOGRAPHICAL SOCIETY (in the Kinematograph Theatre of the Imperial Institute, Prince Consort Road, London, S.W.7), at 5 p.m.—Geographical Sound Films, by courtesy of the Belgian Government: "Nos Soldats d'Afrique"; "Musée du Congo Belge"; and "Sous l'étoile d'or", with commentary in French.

Tuesday, March 24

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Metals", 4: "Strength and Flow of Metals".*

Wednesday, March 25

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting. Prof. H. L. Hawkins, F.R.S.: "Some Episodes in the Geological History of the South of England" (Anniversary Address).

Thursday, March 26

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Art John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Eight third Annual Meeting. 3 p.m.—Sir Stanley V. Goodall, K.C.B. "Sir Charles Parsons and the Royal Navy" (Parsons Memori Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Physicists after the War"

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (JOINT MEETIN WITH THE BRISTOL SECTION) (in the Chemical Department, the Un versity, Bristol), at 6.30 p.m.—Prof. F. L. Engledow: "Science an the Land" (Jubilee Memorial Lecture).

Friday, March 27

INSTITUTION OF CHEMICAL ENGINEERS (at the Connaught Room Great Queen Street, London, W.C.2), at 11 a.m.: Twentieth Annu Corporate Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on before the dates mentioned:

PRINCIPAL OF THE TECHNICAL COLLEGE, COATBRIDGE—The Direct of Education, Lanarkshire House, 191 Ingram Street, Glasgow, C. (March 25).

DEPUTY SUPERINTENDENT, Telegraph Works, Calcutta, for duti as PRODUCTION ENGINEER FOR TOOL AND LIGHT MACHINE SHOPS—The Secretary, Central Register (Section D.261), Ministry of Labou and National Service, Queen Anne's Chambers, Westminster, Londo S.W.1 (March 28).

ASSISTANT IN THE NUTRITION DEPARTMENT—The Secretar Pharmaceutical Society of Great Britain, 17 Bloomsbury Squar London, W.C.1 (April 7).

ASSISTANT (MALE) TO THE PUBLIC ANALYST—The Secretary, Healt Department, Grey Friars, Leicester.

PROFESSOR OF CIVIL ENGINEERING AND DIRECTOR OF THE SCHOO OF ENGINEERING at Canterbury College, Christchurch, New Zealan —The Secretary, Universities Bureau of the British Empire, c University College, Gower Street, London, W.C.1.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 9 Notes on some Lepidopterous Pests on Fruit Trees, and their Parasite in Ireland during 1941. By Dr. Bryan P. Beirne. Pp. 107–118. (Dul lin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgat Ltd.) 1*s*. [17

Committee on Skilled Men in the Services. Second Report and Memorandum by the War Office. (Cmd. 6339.) Pp. 74. (London H.M. Stationery Office.) 1*s*. 3*d*. net. [23

Carnegie Trust for the Universities of Scotland. Fortieth Annu Report (for the Year 1940–41) submitted by the Executive Committe to the Trustees on 16th February 1942. Pp. iv+80. (Edinburgh Carnegie Trust for the Universities of Scotland.) [23

Other Countries

Canada: Department of Mines and Resources, Mines and Geolog Branch: Bureau of Geology and Topography: Geological Surve Memoir 229: Noranda District, Quebec. By M. E. Wilson. (N 2461.) Pp. vii+162 (14 plates). 50 cents. Memoir 231: Bousque Joannès Area, Quebec. By H. C. Gunning. (No. 2463.) Pp. v+11 25 cents. Memoir 234: Mining Industry of Yukon, 1939 and 194 By H. S. Bostock. (No. 2466.) Pp. iii+40. 25 cents. (Ottawa King's Printer) [11

Bulletin of the American Museum of Natural History. Vol. 7 Art. 8: Results of the Archbold Expeditions, No. 39: A Review the Genus *Myotis* (Chiroptera) of Eurasia, with Special Reference Species occurring in the East Indies. By G. H. H. Tate. Pp. 537 565. Vol. 78, Art. 9: Results of the Archbold Expeditions, No. 40 Notes on Vespertilionid Bats of the Subfamilies Miniopterinæ, Mur ninæ, Kerivoulinæ, and Nyctophilinæ. By G. H. H. Tate. Pp. 567 597. Vol. 79, Art. 1: Ticholeptinæ, a New Subfamily of Oreodont By C. Bertrand Schultz and Charles H. Falkenbach. Pp. 105. (Ne York: American Museum of Natural History.) [11

Government of India. Report of the Bio-chemical Standardisa tion Laboratory, 1937–1940 (31st March). By Bt.-Col. Sir R. N Chopra. Pp. v+92. (Delhi: Manager of Publications.) 1.10 rupees 2*s*. 6*d*. [13

Carnegie Institution of Washington. Publication No. 538 Embryology of the Rhesus Monkey (*Macaca mulatta*). Collected Pape from the Contributions to Embryology, published by the Carneg Institution of Washington. Pp. iii+148+52 plates. (Washingto D.C.: Carnegie Institution.) 1 dollar. [17

Gold Coast Timbers. Compiled with the assistance of Officers the Forestry Department, and edited by the Chief Conservator Forests, Capt. R. C. Marshall. Pp. viii+45+iv. (Accra: Governmen Printer.) 1*s*. 6*d*. [20

Land Management in the Punjab Foothills. By Dr. R. Maclaga Gorrie. Pp. v+78+xii+14 plates. (Lahore: Government Printin Office.) 1.6 rupees. [23

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LEADERSHIP IN WORLD RECONSTRUCTION

THE agreement which has recently been signed by the Governments of Jugoslavia and Greece, establishing a Balkan union, like the subsequent announcement that the Czechoslovak and Polish Governments in London had reached agreement on certain basic principles of the confederation to take place after the War, is a reminder that the shaping of the New Europe is already taking place. The extent to which these agreements, clearly regarded both as the nucleus of a wider federation and as steps towards the consolidation of fluid national structures and anarchic political and economic conditions, embody the principles enunciated in the Atlantic Charter, no less than the fact that they have been reached in London, is a token of an inevitable measure of Anglo-American leadership in the New Europe.

It is for this reason that the question of Great Britain's relation to Europe calls for such careful study at the present time. There is, moreover, a further reason, stressed by Mr. P. J. Noel-Baker in the recent debate on the War in the House of Commons. Among our other vital needs, he said, is a European Council or some new and better machinery of European collaboration, because of what might happen in 1942. If we are to deal a mortal blow at the Axis through one of its main weaknesses—its moral bankruptcy—we must make a tremendous effort at political education to show the enemy peoples that our victory is in their own true interests.

That effort involves a careful study of the relation of Great Britain, and indeed of the United States also, to Europe, and gives pertinence to the able analysis already prepared by the Reconstruction Committee of the Royal Institute of International Affairs. Much more indeed is involved. We cannot expect to achieve moral ascendancy and victory without setting our own house in order. There is a sense in which, as Dr. C. H. Gretton argues ably in his recent volume under that title, victory begins at home, and the moral basis of victory, overshadowed in most, though not in all discussions of war aims—Barbara Wootton's "End Social Inequality", in the Democratic Order series of pamphlets is a further example—may well prove to be the decisive factor in either a long or a short war. Decisive victory even over an unjust foe may be delayed until we have cast out our own social injustices and planned our national economy on a rational and just basis. Only the most superficial thinking can dismiss the examination of reconstruction as irrelevant to the mobilization of our full war effort, apart from the necessity of being prepared for the task of reconstruction after the War.

Granted the necessity of a moral basis for reconstruction and its value as a weapon in the supremely important political offensive, the great need, as Dr. J. A. Bowie points out in a Saltire Pamphlet*, is for factual knowledge. A clear picture of the problems involved is a first essential to further investigations, and the great value of the PEP broadsheet, "Britain and Europe", and the Democratic Order pamphlet, "Reconstruction and Peace", by "Balbus" *, and the programme outlined by the Reconstruction Committee of the Royal Institute of British Architects, lies in the contributions offered to that end. The objectives thus visualized and alternative lines of policy outlined lose none of their value by being based on such assumptions as the military defeat of Germany, the continued co-operation of the Dominions and of the United States after the War, and sufficient unity and steadiness in the public mind to permit the effective application of a consistent and reasonable policy.

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* The Basis of Reconstruction. By Dr. J. A. Bowie. (Saltire Pamphlet No. 1.) Pp. 38. (Edinburgh and London : Oliver and Boyd, 1941.) 1s.

It is a common feature of all the pamphlets referred to above that they recognize the necessity of distinguishing between the measures to be adopted immediately after the Armistice and those more permanent measures or policies required later. To some extent they all also recognize that the purpose of Britain's European policy and her general conception of her relation to other European policy must be determined on the basis of the essential facts governing our relations to Europe—geographical situation and communications, population and social standards, industrial and economic potential, political ideas and institutions.

Short-term measures and long-term policy cannot be determined in complete separation, and the British and the American peoples must make an early decision as to whether or not they will accept their responsibilities for leadership in Europe. If an affirmative decision is to command the support that alone can make it effective and win the confidence of the European peoples, it must be based on a full survey of the situation. Moreover, the existing Inter-Allied Council is in itself a guarantee that the measures calling for immediate consideration or action immediately the War ends, such as the occupation of Germany or other territories, the economic and social needs of Europe, such as relief food supplies, prevention of disease, housing, the refugee problem, credit and currency measures, the establishment of orderly government and of civil and political rights wherever required on the Continent, will be dealt with in collaboration with other Governments and with regard for their contribution.

What is essential is that these immediate measures should not be framed without regard to the long-term problems. Here the governing question is that of our relations with Germany and the measures to be adopted to remove the risk of future German aggression. A sound choice between the two alternatives of a policy of co-operation designed to create among the German people a real interest in, and will towards, peace, and a policy of enforced subordination of Germany designed to remove her power to disturb the peace, must be based not alone on a study of the facts and of the implications of those alternatives, the risks implicit in them, the demands each policy would make on us, and the machinery of political co-operation required to give it effect. It must also be based on thinking in terms of Europe and of the role of the German people within the European whole. Only so can we avoid the dilemma of two irreconcilable propositions, which at first sight the German question appears to present.

It is in the long-term economic and social problems that the way of escape from the German dilemma appears to open before us, as is well shown by "Balbus". Here we must first seriously consider the possible choices: a return to the ideal of a great commercial republic, with the implication that the possibility of any country having an autonomous policy is severely limited, or an economy more or less planned to secure economic or social security. That again involves examination of such questions as the practicability of insulating national economy and of running a social security policy on a truly international basis. At this point we link up once more with the question of internal reconstruction, and of the extent to which effective British leadership is possible unless we can show definite domestic achievement in the field concerned.

These questions, indeed, rather than the form of the international machinery required, are the immediate live issues. Much of the machinery created for co-operation in war may serve equally well the immediate purposes of post-war relief, practical reconstruction and the planning of Europe's agricultural and industrial life. Out of the experience of such work, as Dr. Bowie suggests, may develop the political forms necessary to sustain and extend it. By such association for common ends, and the deliberate promotion of understanding of cultural and political values, will come faith and vision widely held, on which it will be possible to base such specific organizations as a European or world federation.

Much the same approach is found in the PEP broadsheet. There the task of building a European commonwealth is seen as consisting of two parallel processes. First, the establishment by Britain and the Allies of a permanent ascendancy over the aggressors, providing the framework of order and security within which the New Europe can begin to grow. Simultaneously with this is the second process of reconstructing and developing European life in the direction of a social and economic and cultural community, which all its citizens have a common interest in maintaining and furthering, and to which all of them, Germans and Italians as well as Danes, Dutchmen, Spaniards and the British, will come to feel a loyalty commensurate with their loyalty to their own countries. To give the New Europe the flesh and blood which alone can make it a living and lasting reality, the peacemakers must set out consciously and boldly to build a European community into which the national communities will slowly merge.

As to the measures by which such broad objectives are to be achieved, in the first stage the broadsheet visualizes a programme of first-aid relief with the necessary organizations, all plans for this emergency period being drawn up as integrated parts of a general

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* Reconstruction and Peace: Needs and Opportunities. By "Balbus". (The Democratic Order, No. 10.) Pp. 64. (London: Kegan Paul and Co., Ltd., 1941.) 1s. net.

plan, related to a clearly formulated pattern of the future Europe. Both the planning and the execution of the programme should be put in the hands of a unified authority or European reconstruction commission, created with wide autonomous powers for the purpose and not left to independent action by the British or any other Government. The second stage will be the development of a new, more coherent, economic and social system in Europe. On the economic side, the system must be directed to the welfare of the peoples of Europe and the progressive raising of their standards of living, and the use of Europe's resources for that purpose should be planned for Europe as a whole and for five- or ten-year periods at a time, not on a year-to-year basis.

On the social side the problem of restoring order out of the disintegration following the collapse of Nazism and Fascism will be urgent, and out of the emergency institutions improvised may grow new social forms of lasting value in European life. Indeed, the key to the restoration of social stability may well be the rebuilding and development into new forms of those cultural and other institutions which are the life-blood of a free community, but which have been persecuted or suppressed in totalitarian Germany—the universities, churches, trade unions, professional organizations, the free Press and the radio. It is here that the long experience of the British people of the value of these institutions in the life of the community gives them such a great opportunity for moral leadership, and, while in the early stages British, Dominion and American personnel are bound to play a leading part in the development of individual leaders, the contribution of the free peoples already represented in Great Britain, whether as émigrés or as refugees from the Nazi tyranny in Europe, will be of the utmost importance in building up a European *élite*. The broadsheet indeed includes a notable suggestion for a special European staff college for training European personnel, possibly linked to the universities as a centre of post-graduate training and research.

The ways and means thus outlined, like the broad objectives they are intended to secure, do not differ greatly except in detail from the broad proposals of "Balbus", who lays first emphasis on reconstruction as insurance against chaos and bloody revolution. His careful analysis of needs and of the mistakes made after 1918 is dominated by a sense of the opportunities which are ours if we are bold and imaginative enough to seize them. The mistake of allowing private finance to dominate reconstruction work must not be repeated, and one of our first aims must be the organization of the State as an instrument of service to society. This responsibility for providing adequate security and freedom to the individual carries as corollary the obligation of a comprehensive scheme of national service from the individual.

"Balbus" sees in the schemes for relief already being mapped out by the Leith-Ross Bureau and elsewhere the stepping-stones to schemes for the development of the backward areas of Europe and Africa and the stimulation of a high level of world trade and production by raising the standard of life and the level of purchasing power in such areas. He stresses the health services and medical work, including the full utilization in Europe of all available medical personnel, notably the considerable number of refugee medical men in Great Britain and in the United States. He urges a reconstruction commission backed by international authority and armed with sufficient powers of control to ensure that neither the profit motive nor political considerations interfere with the task of re-equipping Europe. The problem must be worked out in concrete terms of needs, materials and man-hours. While he would defer the discussion of political reconstruction, he utters a warning against staking too much on economic planning and unduly neglecting political organization.

By placing all relief and reconstruction under an official reconstruction commission, priorities could be enforced which would raise the standard of life in Europe as rapidly as possible, help to develop backward areas, and impose an industrial structure which would cut across national boundaries and place grave difficulties in the way of economic autarchy. The foundation of a raw materials union should be laid in a scheme with adequate consumer representation; and by utilizing the reconstruction commission as its European agency, reconstruction could be linked with development. Moreover, the more effective these economic institutions the less paramount will become the purely political organs of power in Europe.

Such an empirical approach is in accordance with the experience of the British Commonwealth, but the acceptance by Britain of a leading position in Europe means the acceptance of responsibilities on a scale we have scarcely begun to realize. It is not merely a question of keeping an army and air force in Europe perhaps for years to come—which, as the broadsheet observes, may well entail the continuance of conscription at home and of the great Empire air-training effort in the Dominions. It is not merely a question of finding and training the extensive administrative personnel needed for the task—itself scarcely to be achieved without a drastic overhaul of the existing machinery of government and methods of selection of personnel. It is also a question of effecting a revolutionary change in our whole outlook and way of life.

First, there must be a new attitude towards Europe, both among statesmen and people. Only those statesmen can be leaders in Europe who look at things through European and not through parochial eyes, and are prepared to sacrifice what appears to be their own immediate national interests when they conflict with the true interests of Europe. Such an attitude involves a corresponding attitude among the British people and an intensive development of British education in foreign affairs to ensure that the British people regard the affairs of Europe with a more informed and realistic view.

Secondly, since the only enduring leadership is leadership by example, part of our effort for victory should consist not only in framing a vision of a world more acceptable to ourselves and to the people of Europe, but also in giving an earnest of our faith by beginning its application here and now. It is certain that Britain cannot even be the agent of Anglo-Saxondom in Europe, and promote that vital American interest in the emergence from this War of a stable and prosperous Europe, integrated into the economic life of the world, and led by statesmen who share the fundamental beliefs and values of the American peoples, unless those statesmen see in the peoples of Great Britain and the United States a dynamic and forward-looking society. To set our own house in order, and at the same time to work out for ourselves and for Europe a new and more satisfying social philosophy than either we ourselves have possessed in the past or than Europe has been offered in the existing Continental ideologies is one condition of our retaining our position in Europe. It offers not merely one of the surest prospects of continuing accord in Anglo-American relations, but also an opportunity of seizing the great opportunity that has opened in Anglo-Soviet relations.

Stimulating and suggestive as are the pamphlets referred to above, they are still more welcome for the evidence that constructive minds are already at work probing the problems and seeking to mould the mind of the nation to grasp its opportunities, and to uphold the affirmation of the Atlantic Charter that we will not once again leave unfinished the job we have taken in hand.

FORM AND CHARACTER

Why Men Behave Like Apes and Vice Versa

Or Body and Behavior. By Earnest Albert Hooton. Pp. xxv+234+22 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1941.) 18*s.* 6*d.* net.

THE present eclipse of anthropology as an active science, while no doubt partly a result of the War, is very largely an outcome of the growth of nationalist doctrines in Europe during the past decade. Ever since the rise of Hitler, reputable anthropologists have been abandoning orderly scientific work in order to devote more and more of their energies to refuting *a priori* doctrines of race—for example, those which form part of the foundation of Nazi political philosophy. The immediate result has been the transformation of the international anthropological scene into one camp of propagandists which supports such doctrines, and another the main purpose of which is to expose their lack of scientific basis. A more serious consequence of the politico-racial 'red herring' is that human biology, which may be conceived as the discipline the responsibility of which is to co-ordinate studies of the biological history and relationships of different peoples, as well as studies of their genetic make-up and behaviour, has been largely side-tracked into unprofitable polemics. These fields of inquiry will have to be explored again if there is to be any sustained rational approach to the wider social problems, not least of which are the Colonial problems, which must be faced at the end of the War. That they will emerge in full vigour is certain, not only because of necessity, but also because of the enthusiastic faith shown in this field of correlated studies by a small band of devoted anthropologists and social biologists.

Prof. Hooton is one of this band in the United States. In Great Britain he is already well known for a popular exposition of human evolution entitled "Up from the Ape". Like his earlier work, "Why We Behave like Apes and Vice Versa" is wittily and vigorously written in terms understandable to the general reader, and is in scope wide enough to include both factual statements about a mass of recent findings in various fields of study and provocative opinions on a number of current topics. Its purpose is to inquire into the extent to which differences in the physical make-up of different peoples determine differences in behaviour. Perhaps it would be more correct to say that its purpose is to disclose Prof. Hooton's profound conviction that the one does influence the other, and that "environmentalists" are incorrect in attributing differences in social behaviour of different groups entirely to differences in social surroundings, habit and opportunity. For, if anything, Prof. Hooton overstates a case which few students would care to dispute. He himself would be the last to deny the view that external factors do influence behaviour, yet the polemical form of the discourse frequently makes one feel that, to prove his own point, he would go very far in disregarding them.

The book opens with an account of the functional relationships and differences in behaviour of different types of monkey and ape. This leads to the conclusion that in the sub-human categories of the order of Primates "behaviour is probably as diversified as organic structure and indissolubly associated with it"—although probably conditioned and altered by environmental adaptation. From this conclusion Prof. Hooton passes to a brief consideration of the essential differences between the human and sub-human primate, and then to a discussion of the physical and cultural diversity of prehistoric man. Again the conclusion is drawn that two types of fossil man, the Sinanthropus-Pithecanthropus group and the Neanderthal group, were almost as differentiated in behaviour as in anatomical characters.

The discussion then moves to existing man, who culturally is broadly classified according to whether his method of subsistence is "artificial" or natural, that is, food-gathering and hunting. The "artificial" group is again subdivided into "civilized" and "uncivilized" sections, which distinguish a stage of urbanization from a predominantly rural and agricultural phase of life. Prof. Hooton believes that the cultural differences between savages and countrymen on one hand, and urban dwellers on the other, are paralleled by physical differences mostly imposed by differences in motor habit arising out of their different ways of life. More detailed racial differences are also posited by Prof. Hooton, who then proceeds, by a consideration of examples from the main divisions of the human species—the Australoid, Negroid, Mongoloid and the White—to show that race may be coterminous with culture, as well as that the two are sometimes mutually independent. Their association seems well marked in such 'primitive' types as the Australian aboriginal and the South African Bushman. Their independence is, of course, usual in large mixed populations. Prof. Hooton concludes his dissertation with a vigorous statement of his belief in the existence of distinct physical types in mixed white populations and in their association with specific forms of behaviour.

It is here that the more cautious student may be inclined to find Prof. Hooton's conclusions somewhat too far in advance of the facts, and his advocacy of certain points too vigorous. The general view that physically similar individuals behave alike he has answered—as he puts it, to his own satisfaction and to the "frenzied disapproval" of others—by a study of the correlation between types of criminal offence and different physical characteristics. The original data are not discussed in the book under review, but, neglecting altogether for the moment the question of the possible correlation between crime and social and economic status, one may be permitted to make the general observation that, since conventions of 'crime' differ between different peoples and at different times, the correlation suggested by Prof. Hooton might not hold in a social environment different from the one in which he studied it.

Furthermore, while a definition of constitutional types is broadly possible, and in general referable to certain psychological distinctions—a relation which even the non-scientific man has for centuries recognized—the detailed classification of physical types which Prof. Hooton accepts presents too many anatomical shortcomings (many of which he himself points out) to justify wide generalization.

A further difficulty is that Prof. Hooton often gives the appearance of confusing the question of racial differences with that of the correlation in a mixed population of different patterns of behaviour with specific physical types. Both problems are immensely important, but they are largely distinct—even though they may overlap. Racial types cannot be created *a priori* by the anthropologist—notwithstanding Prof. Hooton's assertion that in classifying men on the basis of physical resemblance he would be prepared to put siblings, if necessary, in different racial groups.

The anthropologist's responsibility is to define the physical and psychological characteristics of declared racial groups the individuals of which are linked in blood-ties—and to do this not only in the isolated pockets of humanity where a correlation may be found between racial type and behaviour, but also in regions where a declared racial type has spread into an environment in which specific patterns of behaviour, and even specific physical characteristics, no longer remain immediately obvious. Isolation—either physical or psychological—and conversely the opposite of isolation, may be far more potent determinants of social behaviour than racial physical characters. Until the relative strength of the two factors has been decided by the most rigorously controlled observation, wide generalizations such as "human evil is not a product of human institutions but of human beings" will continue to be dangerously double-edged.

So, too, it is perhaps premature to follow Prof. Hooton in his far-reaching eugenic predictions about the possible effect of family limitation on the physical and social character of future populations. If indeed we knew enough about human biology to produce the 'better' men to whom he looks forward, why limit their number as he would have us do ? Why not fill the world with them ? The manner in which these particular views are put forward suggests, however, that some of them are Prof. Hooton's demonstrations of kite-flying, while others are Aunt Sallies, which he occasionally knocks down before the reader has a chance to get at them.

The total effect which Prof. Hooton has produced is a readable, stimulating and amusing book which demonstrates the scope of the conclusions that could be reached with fuller knowledge.

S. ZUCKERMAN.

AGRICULTURE ON A NATIONAL SCALE

Agriculture's Challenge to the Nation

By Arthur Smith. Pp. x+236. (London and Toronto : William Heinemann, Ltd., 1942.) 8*s*. 6*d*. net.

ONE of the hopeful features of our national life to-day is the widespread interest now being taken in our agriculture. Rarely have so many policies been propounded or books issued, which clearly the public is prepared to buy. There is a growing tendency to expect the State to take a larger and larger part in the business, though how far this would survive in actual practice would remain to be seen.

In the present book Mr. Smith goes further than most of his predecessors, and almost makes the farmer and the farm worker into salaried officials ; at least the risks are to be more heavily shouldered by the State and the returns both to farmers and workers are to be increased.

The author sets out to bring into use some forty-seven million acres in the United Kingdom, sixteen million being arable and thirty-one million grass. This is, of course, considerably more land than is in agricultural use at present, and the scheme necessitates a good deal of reclamation and development of rough grazings and deer forests. The main arable crops would be oats, of which there would be four million acres, half for human consumption and half for poultry and other livestock ; next would come wheat and lucerne in the dry areas ; and then enough sugar beet to provide our pre-war sugar allowance and sufficient barley to give a "reasonable drink allowance". Haymaking would be replaced by ensilage and grass drying. Beef production would be eliminated as too costly in feeding-stuffs, but as milk production is to be increased it is not at all clear what use is to be made of the bull calves inseparable from that activity. For you cannot have milk until the cow has produced a calf, and she has to go on producing a calf annually if her milk yield is to continue. Approximately half her calves are males useful only for conversion into beef. Sheep, pigs and cattle would be pastured on the hill lands, the cattle being used for butter production.

Prices would be such that the men workers would receive a minimum wage of 60*s*. a week for forty-eight hours and the women and youths would receive 48*s*. There would be processing factories in the villages at which other members of the family could work. A family might as a whole be drawing £15 weekly. The farmer would be paid according to the area of land he occupied. He would live free of rent, rates and taxes on the land he farmed. He would receive free of charge all implements and machinery, seeds, fertilizers, stock, etc., necessary to his farming, and in addition a salary of £4 per acre on the first fifty acres, £3 per acre on the next 150 acres, £2 per acre on the next 150, and £1 per acre on all acres above 350. In return, the produce would belong to the nation.

There is little doubt that farmers in Great Britain would be interested in a scheme of this sort which goes far beyond their most sanguine hopes. But the crux of the problem is this : Would the nation ? Until some big national pronouncement is forthcoming, policy-making remains uncertain.

E. J. RUSSELL.

PHYSIOLOGY OF THE AMINO ACIDS*

By DR. DONALD D. VAN SLYKE
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THE number of proteins in the animal and vegetable world appears to be infinite. Yet they are all constructed of a relatively few units, namely, the amino acids. These amino acids in number are about equal to the letters of the alphabet. They have an extraordinary facility for being joined in chains; each amino acid has the same head and tail, so that the tail of one can link with the head of another, and the linking can be repeated apparently times without limit. Each amino acid has an H_2N, or amino group, which has an alkalinity about equal to that of ammonia; and each has a COOH or carboxyl group, which has an acidity about like that of citric acid. There is also a chemical group, *R*, which is different in each amino acid, and gives it its character as an individual. Hence we may call the *R* group the *individualizing* group of each amino acid. The amino and carboxyl groups neutralize each other, so that if the individualizing group is neutral the amino acid is neutral; such are alanine, glycine, leucine. However, if the individualizing group is alkaline the amino acid is alkaline; such are lysine, arginine, and histidine.

Aside from its acid or basic properties, each individualizing group bears other chemical properties. In serine, threonine, and hydroxylysine, for example, the individualizing group bears a hydroxyl with all the reacting powers of an alcoholic hydroxyl. Again, the individualizing group may carry a second carboxyl; then the amino acid is strongly acidic: such are aspartic and glutamic acids.

In cystine and methionine the individualizing group has a sulphur atom. The cystine sulphur can take up a hydrogen atom to form cysteine, and when this occurs to cystine in a protein molecule the entire character of the protein is changed. In wool and hair the sulphur is in the oxidized -C-S-S-C- form of cystine, and the proteins are utterly insoluble and indigestible. If the -C-S-S-C- is reduced to two -C-SH groups, forming cysteine, the wool is changed into proteins which are easily digested.

In proteins Emil Fischer demonstrated that the amino acids are joined, head to tail, by what he termed peptide linkings, each NH_2 group condensing with the COOH of another amino acid, with elimination of the elements of water. Simple chains of a few amino acids Fischer termed peptides. The dipeptide glycolalanine still has a free NH_2 group and a free COOH, where two more amino acids can be linked on, and the process can be repeated *ad infinitum.*

The proteins are peptides of tremendously long chains. These chains seem usually to be rolled into balls, like balls of yarn, or otherwise made to take globular or ellipsoid shape, for their rates of diffusion were found by Northrop and Kunitz to approximate to those calculated for spheres. Exceptions are the fibrous proteins, silk and wool, of which the molecules themselves appear to be extended into fibres.

In the human stomach the protein molecules meet the pepsin of the gastric juice, which unrolls the balls and breaks the overgrown chains into shorter ones, which are still fairly long, and go under the general name of 'peptones'. The chief visible change in the stomach, as noted a century ago by Beaumont in the stomach of Alexis St. Martin, is that proteins which enter the stomach as insoluble matter, such as meat or coagulated egg white, leave the stomach and enter the intestine largely changed to soluble material.

We may pause here to point out one fallacy that has crept into the practice of medicine through a perfectly correct observation by Beaumont. He noted the times necessary for various foods to remain in the stomach before they were turned into soluble material and passed on into the intestine. He found that raw egg albumin was one of the quickest protein foods to pass through. From this it has been concluded that raw egg white is one of the most easily digested proteins. The fact is that it is one of the most resistant to digestion. It passes quickly and easily through the stomach because it happens to be soluble, and it reaches the intestine largely in its original undigested state. The digestive reserves of the intestine are so great that they normally complete the work of breaking down the egg protein chains. However, the egg protein is one of those which are most likely to be absorbed in the undigested state, and to cause sensitization, particularly in infants. In fact it is said that raw egg white fed to an infant has been observed to be absorbed in such amounts that it reappeared in the urine. The most digestible form in which egg proteins can be fed is that obtained by coagulating them with thorough cooking, and then breaking the material into finely divided particles by passage through a sieve.

In the intestine the gastric products meet the enzymes secreted by the pancreas and the intestinal wall. It used to be thought that the trypsin of the pancreas had the power to break at least part of the peptide chains completely to amino acids, but it now appears that trypsin can carry the digestion no further than to the stage of peptides of the average size of six or seven amino acids per peptide molecule.

Dr. Robert Dillon and I succeeded some years ago in devising a method of analysis which was specific for free amino acids. It depended on the ability of a mild oxidizing agent called ninhydrin, which first attacked the amino group of the amino acid, breaking off NH_3 from the $R.CH(NH_2).COOH$, and leaving in its place the keto acid $R.CO.COOH$. Boiling decomposes the keto acid into aldehyde and carbon dioxide. The actual analysis consists merely in boiling the amino acid and ninhydrin together and measuring the carbon dioxide evolved.

For the series of reactions that end in the evolution of carbon dioxide it is apparent that one must have *both* an NH_2 group and a COOH group in adjacent positions, and this is the definition of an alpha-amino acid. If either the NH_2 or the COOH group is tied up in a peptide linking, the reaction cannot go through to a finish and no carbon dioxide is evolved.

With this method Dr. MacFadyen, who followed Dillon in our laboratory, was able to show that purified crystalline trypsin splits protein to peptides, but not to free amino acids, but that 'crude trypsin', comprising a mixture of the pancreatic enzymes, goes much further and splits many of the peptides into free amino acids. It is evident that the pancreas produces peptidases as well as trypsin, but that pure trypsin is not a peptidase with the power to accomplish the last step of protein hydrolysis, namely, to set the amino acids free.

Although the trypsin alone does not carry digestion to the stage of free amino acids, experiments both

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* Substance of a paper read at the Fifteenth Anniversary Celebrations of the University of Chicago on September 23, 1941.

in vitro and *in vivo* have shown that the mixture of pancreatic and intestinal enzymes does produce free amino acids. Whether all the protein products in the intestine are digested to free amino acids before they are absorbed is not certain, but it does appear that the greater part of these products are absorbed as free amino acids. The evidence of this is that during protein digestion there is an increase in the free amino acid content of the mesenteric blood, and also of the blood of the general circulation, but reliable methods have failed to demonstrate an increase in peptide nitrogen, of which very little is present.

The speed with which digestion begins was evidenced by experiments of Cullen and McLean in which dogs were fed meat, and the blood was analysed for urea at short intervals. Within fifteen minutes the blood urea content had risen 10 per cent, indicating that a measurable part of the protein had already passed through all the stages, not only of digestion, but also of absorption and degradation. The process once started goes on steadily until absorption of the ingested protein is completed. The length of time required for completion varies in proportion to the amount ingested, but is usually 2–4 hours.

To find where the absorbed amino acids were taken from the blood, and what happened to them, Cullen and McLean anæsthetized dogs during digestion and quickly drew blood from the portal vein between intestine and liver, from the mesenteric vein leaving the liver, and from the vena cava, where blood from all the tissues is mixed. It was found that the amino acid content of the blood rose about 20 per cent as the blood perfused the intestines, and that the greater part of the absorbed amino acids were removed by the liver. In return, the liver poured into the blood of the hepatic vein an amount of urea nitrogen which almost balanced the amino acid nitrogen that had been taken up. One could watch the work of the liver in taking up the amino acids and destroying them, turning their nitrogenous parts into urea for excretion by the kidneys.

Other experiments, performed with Dr. Gustav Meyer, showed that the liver did not get quite all the absorbed amino acids, but that some escaped, and could be absorbed by other tissues. In order to magnify the effects of such absorption blood amino acid concentrations were raised to high levels by intravenous injection of amino acid solutions. Portions of muscle, kidney, and liver tissue were analysed for amino nitrogen before and after the injections. It was found that even in the fasting animal the amino acid concentration in the tissues was about eight times as great as in the blood plasma, namely, about 40 mgm. of amino acid nitrogen per 100 gm. of tissue, compared with 5 mgm. per 100 gm. of plasma. When amino acids were injected the amounts taken up by the glandular organs were much greater than by the muscles. The content of the muscles in amino acid nitrogen rose to about 60 mgm., of the kidneys to about 80 mgm., and of the liver to about 120 mgm. per 100 gm. of tissue. During the next three hours the amino acids in the muscles and kidneys remained practically unchanged, but the amino acids in the liver almost fell back to their original level, and an equivalent of urea nitrogen appeared in the circulation.

The evidence in these experiments, that the liver is the organ where urea formation takes place, supported an ancient but much contested hypothesis that the liver is the only organ that forms urea. Its unique distinction in this power was clinched by Bollman, Mann, and Magath, of the Mayo Clinic, who showed that removal of the livers from dogs led to an accumulation of amino acids in the blood, and entirely stopped the formation of urea.

The chemical steps by which the nitrogen of the amino acids is converted by the liver into urea have been demonstrated by Krebs. The nitrogen is first oxidized off as ammonia. Two molecules of ammonia then combine with one of the diamino acid, ornithine, to form the 4-nitrogen amino acid arginine. The arginine is then hydrolysed by the enzyme arginase in the liver, with formation of one molecule each of urea and ornithine. The net result is to change the highly toxic ammonia into the non-toxic and highly diffusible urea, an end-product ideally suited for transportation to the kidneys and excretion. The ornithine can go through the cycle an indefinite number of times, taking up two molecules of ammonia and giving them off as one molecule of urea. The ornithine thus acts as a true catalyst. Liver had been demonstrated years before by Dakin to be rich in the enzyme arginase, which hydrolyses arginine to urea and ornithine, but the physiological purpose of the arginase in the liver had been a mystery until Krebs' work showed its role in the final step of urea formation.

Another vicissitude of the amino acids which the work of Mann and his colleagues located in the liver is the transformation into glucose. Graham Lusk, in the early part of the century, showed that when protein is catabolized by dogs made totally diabetic by phloridzin poisoning, about 60 gm. of glucose was formed and excreted from each 100 gm. of protein catabolized. Lusk and his collaborators also showed that certain of the amino acids had their carbon partly or entirely turned into glucose when their nitrogen was turned into urea. Mann and his colleagues showed that no glucose formation from proteins or amino acids occurred when the liver was excluded.

Furthermore, the acceleration of the body's heat production that occurs during assimilation of protein digestion products was shown by Mann and his colleagues not to occur when the liver was excluded. This accelerated heat production, called by Lusk the "specific dynamic action", apparently either represents energy produced by the reactions which the amino acids undergo in the liver, or is caused by other reactions in the cells which are stimulated by the presence of products formed in the liver. Such substances must be other than the urea and glucose, for neither of these shows the observed amount of stimulating effect. The specific dynamic effect may be due either to heat evolved from reactions that occur in the liver, or to the effect of products, other than urea or glucose, in stimulating other heat-producing reactions in the body. The decision between these two possibilities awaits future exploration.

Not all the treatment met by the amino acids in the liver is destructive. During periods of heavy protein feeding the body stores considerable amounts of protein in the liver and to a less degree in the other tissues. The protein seems to be different from the structural proteins of the tissues. In the liver Berg has shown that it can, in fact, be differentiated with the microscope by its droplet structure in the cells. Functionally it is characterized by the readiness with which it is metabolized when the protein intake is decreased, or with which it is used to replace blood proteins depleted by hæmorrhage, as found by Whipple and his colleagues. It appears probable that this protein is constructed in the liver part of the amino acids brought to it from the intestine.

Besides the liver, all the living tissues of the body take their shares in the metabolism of the amino acids, for all of them are of substance chiefly protein, and it is a living protein that is continually being broken down and rebuilt from its constituent amino acids. A most interesting part of this process has recently been discovered by two Russian biochemists named Braunstein and Kritzman. It is called 'transamination', and it enables the cells to change keto acids to amino acids by replacing the oxygen atom of the ketone with ammonia, transferred to the CO group of the ketone acid from the CH(NH$_2$) of either of the dicarboxylic amino acids, aspartic and glutamic. Since at least some of the keto acids can be produced by partial oxidation of carbohydrates, transamination appears to be one of the processes by which the body can construct a portion of its own amino acids; and it has been well established that the body can in fact synthesize about half the amino acids that are found in its protein structures. The reaction of transamination is caused by an enzyme that occurs in all the tissues, but is particularly rich in the muscles.

It is a peculiar thing that only the acidic amino acids, glutamic and aspartic, with two carboxyl groups each, can give their nitrogen to keto acids. Monocarboxylic amino acids, such as glycine and alanine, cannot transfer their nitrogen to keto acids to and from each other. However, they can transfer their nitrogen to keto-succinic and keto-glutamic acids to form aspartic and glutamic acids; this is a reversible process. With aspartic or glutamic acids as an intermediary step, therefore, it seems to be possible for leucine, for example, to transfer its amino group to pyruvic acid and make alanine, or in reverse, for alanine to donate its nitrogen to make leucine from its keto acid. In either case the shifting nitrogen first is transferred to glutamic as aspartic acid, and then from that to the keto acid. The transfer is affected by an enzyme, which one of its investigators, Cohen, suitably calls transaminase; it has been separated in the form of a protein from tissue extracts and exerts its activity in the absence of living cells.

From the fact that by the transaminase action the body can build up at least some of its own amino acids it would follow that not all the amino acids in the body proteins need be provided ready-made in the food proteins, but that some can be made in the body provided the necessary products to form the keto acids are available. In fact, thirty-four years ago Magnus-Levy demonstrated that the rabbit can make the simplest amino acid, glycine. When benzoic acid is fed to an animal it is detoxified by conjugating it with glycine to form hippuric acid, which is excreted in the urine. Magnus-Levy, by feeding hippuric acid to rabbits on nitrogen-free diets, was able to make them excrete as hippuric acid more glycine than they had contained in their entire bodies. They had used other nitrogenous materials to build glycine in order to detoxify the hippuric acid. The task of finding which of the other twenty amino acids are indispensable parts of the diet and which one the animal body can build for itself has occupied some of the leading biochemists since the time of Magnus-Levy's demonstration. The names of F. Gowland Hopkins in Great Britain and of Lafayette Mendel, T. B. Osborne, and W. C. Rose in the United States have been especially brilliant in the list of those who have unravelled this problem step by step. It has required clever and painstaking work to devise diets that contained all the necessary constituents for growth except one amino acid, and to handle the animal experiments in such a manner that the results were unequivocal. In the course of these studies W. C. Rose found evidence from his rat responses that there was some previously unknown constituent of hydrolysed casein which was necessary for maintenance, and in searching for it discovered and identified the amino acid threonine. As the result of twenty years of work by all the investigators in the field, Rose finally was able to divide them all into two groups, one comprising the amino acids which must be supplied as such in the food, while the other group can be made by the body and need not be supplied in the protein food.

Essential amino acids (Must be supplied ready-made in the diet)	Non-essential amino acids (Need not be supplied in the diet)
Lysine	Glycine
Tryptophane	Alanine
Histidine	Serine
Phenylalanine	Norleucine
Leucine	Aspartic acid
Isoleucine	Glutamic acid
Threonine	Hydroxyglutamic acid
Methionine	Proline
Valine	Hydroxyproline
Arginine	Tyrosine
	Cystine

The extent to which nitrogen fed in the form of amino acids is synthesized into tissue proteins, both in the form of the fed amino acids and of other amino acids to which the nitrogen is transformed by transamination, has been studied brilliantly by Schoenheimer and his colleagues in the Departments of Chemistry and Physics at Columbia University. They have synthesized amino acids with heavy nitrogen, ^{15}N, have fed the amino acids to rats and mice, and finally have hydrolysed the proteins in their bodies and isolated various amino acids from the hydrolysates. Finally, they have analysed the isolated amino acids for ^{15}N to determine the amounts of the ingested amino acid that were built into the body proteins, both in the form of the administered amino acid and in the form of other amino acids, formed from the administered one by transamination or other reactions. They have found that incorporation begins almost immediately, and that, while more of the marked ^{15}N is found still in the amino acid with which it was administered than in any other amino acid, nevertheless a considerable proportion of the marked nitrogen was found distributed among the other amino acids.

The results of Schoenheimer and his colleagues have entirely dispelled the view that the tissue proteins when once laid down remain as unchanging structural blocks until eventually destroyed by the wear and tear of metabolism. It appears that every protein molecule in the living body is itself alive in the sense that it is continually changing and renewing its structure.

Transmethylation. The discovery of du Vigneaud that methyl groups can be transferred from methionine to other substances in the body has opened a new field rivalling in interest that of transamination. Du Vigneaud found that some substance in the vitamin B complex could be replaced by methionine. This substance he identified as choline, which is thus identified as one of the necessary vitamins. Du Vigneaud proved that the choline could be formed with the aid of methyl groups from methionine, by administering methionine in which the methyl group was marked by having one of its hydrogens in the form of deuterium. When this labelled methionine was fed to rats on a choline-free diet, choline could be isolated from their tissues with part of its methyl groups containing the deuterium. It was found that this marked methyl group could be further transferred from the choline to creatine. The methyl group of the amino acid methionine could therefore be used by the body in synthesizing two of its essential non-amino acid constituents.

Detoxifying effects of amino acids. We have already noted the manner in which the body uses glycine to combine with and detoxify benzoic acid by forming hippuric acid. In some much less obvious way cystine and methionine protect the liver from intoxication by chloroform. This peculiar effect of the two sulphur-containing amino acids was discovered in 1940 by Miller, Ross, and Whipple. They had observed that a heavy feeding of meat would protect a dog from the effects of a dose of chloroform that would have led to fatal liver degeneration if administered in the fasting state. Investigation of the different types of amino acids yielded by protein digestion proved that only the two containing sulphur had the protective effect.

Concentration of amino acids in the blood plasma and the effect of the endocrines upon it. In the normal fasting adult the concentration of amino acid nitrogen in the plasma is constant at 5 mgm. per 100 c.c. If amino acids are absorbed from a protein digest or are injected intravenously there is a transitory rise, and a return soon to the original fasting concentration. The changes in blood amino acid concentration are similar to the changes of blood sugar after administration, orally or by vein, of glucose. There is an equilibrium between the amino acids of the tissues and those of the blood plasma, with the concentration in the tissues ordinarily eight or more times greater than in the plasma. What the forces are that maintain such an unequal balance is not known, but, as in the case of blood glucose, the endocrines have been found to be factors in the control of the plasma concentration. Luck and his collaborators have shown that administration of either insulin or adrenalin lowered the plasma amino acid content of animals. Mirsky has shown that insulin greatly retarded the passage of amino acids from muscles to blood in eviscerated dogs. The effect of insulin on the blood amino acids is much like that on the blood sugar. The opposite effect, to increase the plasma amino acid content, is shown by some of the other hormones. Thus Farr and Alpert in our laboratory have recently found that intravenous administration of the growth- or metabolism-stimulating factors of anterior pituitary extract, of antuitrin, pitressin, or adrenal cortical hormone was followed in dogs by increase of the plasma amino acid content.

Blood amino acid concentrations in disease. From the manner in which hormones can influence the concentration of amino acids in the plasma it is evident that the interpretation of changes found in disease may be difficult. If the plasma amino nitrogen content were merely the mechanical resultant of inflow from the intestines balanced against absorption and metabolism by the tissues, one would anticipate that liver damage would result in a retarded removal of amino acids from the blood, in abnormally large increase in plasma amino acid content during digestion of protein foods, and in abnormally slow return of the plasma amino acids concentration to normal after injections of amino acids. In fact all these results have been reported by various authors, but they seem to be definite only when the hepatic damage has reached a severe grade. This might be expected from the experiments of Frank Mann with partially hepatectomized dogs. He found that it was necessary to remove 80 per cent of the liver before the blood amino acid content began to rise. It does not appear therefore that one can expect blood amino nitrogen determinations to afford a delicate means for detecting moderate degrees of liver injury.

In Bright's disease two extraordinary changes of plasma amino acid content in opposite directions have been observed in our laboratory. One of them was discovered by Kirk in patients in or near uræmic coma. The plasma amino acid nitrogen in some of these patients rose in a day or two from but little above the normal level to six- or eight-fold as much. If, by treatment with saline and glucose injections and other therapeutic measures, recovery from the severely uræmic state could be induced, the plasma amino acid content fell as quickly back to normal. The sudden rise might be explained as due to an accelerated tissue breakdown accompanied by a simultaneous failure of deaminizing function of the liver, but there was no independent evidence that either of these conditions occurred. The mechanism of the amino acid rise in uræmic coma remains a puzzle.

In the opposite direction, Far and MacFayden, using the ninhydrin method first worked out with Dr. Robert Dillon, showed that children with nephrosis are likely to have chronically subnormal plasma amino acid values. But, of particular interest, is the fact that when the patients have the sudden illnesses known as 'nephrotic crises', when sudden collapse occurs without infection or any other obvious cause, the plasma amino acid nitrogen shows precipitate falls to as low as 2 mgm. or even 1 mgm. per 100 c.c. Whether the cause is an endocrine-influenced shift in the equilibrium between blood and tissues, or some factor that is as yet totally unidentified, remains uncertain. However, regardless of the mechanism of the plasma amino acid fall, the injection of generous amounts of amino acids in the form of predigested milk proteins has regularly produced a marked alleviation of the collapse, and a great reduction in the mortality from these attacks.

Nutrition by intravenously injected amino acids. Shortly after early work cited in this article showed that amino acids were absorbed from the intestine during protein digestion in amounts sufficient to account for all the nitrogen digested, Henriques in Copenhagen demonstrated that nitrogen equilibrium could be maintained with intravenously injected amino acids as the sole intake. He placed a cannula in the neck vein of a goat kept in a stall, and maintained the animal in nitrogen equilibrium for several weeks by giving the great part of the necessary nitrogen in the form of a protein digest hydrolysed completely to amino acids and injected intravenously. The therapeutic application did not follow until twenty years later, when Ellman began the regular use of intravenous injections of predigested casein. He was followed by Farr and MacFadyen, who showed that the injected amino acids were assimilated fully as well as the nitrogen from ingested proteins digested in the alimentary tract. A large part of the nitrogen required can be given in this form over a period of weeks. It appears that this form of nutrition can well supplement intravenous calories in the form of glucose in conditions that prevent adequate feeding by mouth.

SIR WILLIAM BRAGG, O.M., K.B.E., F.R.S.

BRAGG'S first research paper was published in 1904, when he was forty-two years old. This fact is not without significance for an understanding of his work and character. He had gone out to Australia as a young man of twenty-four, without any experimental experience and without, indeed, any real training in physics—he was fond of telling how he learnt the elements of the subject on the boat as he travelled to take up his appointment as professor of mathematics and physics at Adelaide. He soon showed a liking for experiment and set up the first X-ray tube to operate in Adelaide, possibly the first in Australia. He made a name as a teacher and as a man of great social gifts, and might have spent a pleasant and useful life without ever carrying out any original investigations, for in those days 'research' was not a professional necessity. It was not until he had had long experience in expounding the fundamentals of his subject, and in so doing had developed a keen critical sense for what was important and what was trivial, that he set out to discover something about radioactivity, a subject that had stirred his active curiosity when he was preparing an account of what had been done in this field. So well, however, had he taught himself in those years of preparation that his first paper, on the range and ionization of alpha particles, is a classic. Within three years he had been elected a fellow of the Royal Society.

Many characteristics of Bragg's scientific work were shown in his Australian days. He never attacked a problem until he had a clear and simple picture before him of what he wanted to do, and he was never satisfied until he had a clear and simple answer to his question. The task he set himself was always one of deep significance, his exposition was always lucid and persuasive and he was always generous in his acknowledgment of the work of others. His gift of stimulating those about him to fruitful endeavour was also shown throughout his life. In Adelaide he made an enthusiastic collaborator of Kleeman, while his school of research at the Royal Institution is world-famous and has attracted students of varying degrees of maturity from all parts of the world. Nothing hasty, nothing immature, nothing of that pretentious work the triviality of which is disguised by its difficulty and obscurity ever came forth from his laboratory. His work, like his personality, was simple yet profound, sincere and compelling.

Bragg was born on July 2, 1862, the son, as he liked to recall, of a yeoman farmer of Cumberland. After a brilliant school career he went to Trinity College, Cambridge, with a major scholarship and studied in particular mathematics. He was third wrangler in 1884, gaining a first class in Part III of the Tripos in 1885. It was in 1886 that J. J. Thomson casually suggested to him that he should apply for the post at Adelaide, which he obtained, and he was professor there until 1908. He quickly endeared himself to his colleagues and fellow-citizens, showing the talent for making friends and winning affection which was so marked all his life. He never wooed popularity deliberately, being, at bottom, somewhat diffident about his own powers and qualities, but he had a charm of manner and a pretty patience with what Karl Pearson used to call "our weaker brethren" that won all with whom he came in contact. In Adelaide he married Gwendoline, daughter of Sir Charles Todd, and there all his three children were born—the present Sir Lawrence Bragg; Gwendy, now Mrs. Alban Caroe; and Robert, who was killed at the Dardanelles. Australia left a deep mark on Bragg's life and he always spoke with affection of the years which he spent there. Scientifically, this period of his life is characterized by the fundamental work on alpha rays to which reference has already been made.

In 1908 he returned to England as Cavendish professor of physics at Leeds. He speedily established his name as a teacher and wrote a monograph on alpha rays published in 1912 under the title "Studies in Radioactivity". It was in the Leeds days that he began to be deeply concerned as to the nature of X-rays, a problem which was exercising the scientific world. It had been contended in some quarters that they were of a wave nature, but the doubtful results of certain attempts to produce diffraction had militated against the general acceptance of this view. Bragg himself inclined to the opinion that they were of the nature of a particle, an electrically neutral doublet, when in 1912 von Laue's fundamental discovery revealed that they possessed the properties of light of an exceedingly short wavelength. It is characteristic of the balance of Bragg's mind that while he at once grasped the significance of von Laue's work, at the same time he still contended that a wave nature left some things unexplained. With rare prevision he wrote in NATURE at the end of 1912: "the problem then becomes, it seems to me, not to decide between two theories of X-rays, but to find, as I have said elsewhere, one theory which possesses the capacities of both."

Following a paper by his son in which the reflexion law was established he began, in collaboration with him, the classic work in which was demonstrated the existence of monochromatic X-radiation and the possibilities of applying X-rays to the investigation of crystal structure. The first joint paper, "The Reflexion of X-Rays by Crystals", appeared in 1913 and the joint book, "X-Rays and Crystal Structure", in 1915. A reprint of the early researches of the two Braggs appeared in German in 1928.

This work on X-rays and crystal structure, which Bragg often expounded in terms so simple as to make it all seem inevitable, laid the foundations of one of the most beautiful structures of modern science. It was used for fundamental advances in both inorganic and organic chemistry. Metallurgy is deeply indebted to it. The names of those who were initiated into research in this field by Bragg—if we mention Astbury, Bernal, Mrs. Lonsdale, Müller, Patterson, Monteath Robertson and Shearer we recognize that there are others with equal title to be cited—recall some of the developments for which he was directly responsible. Bragg retained his active interest in the subject and showed all his freshness of approach up to the end. His last paper dealt with the extra reflexions in X-ray photographs, which aroused all his old enthusiasm and flair for a simple explanation.

To return to his career, the War of 1914–18 found him at Leeds. He was appointed Quain professor of physics at University College, London, in 1915, but his time until the end of the War was devoted wholeheartedly to war service. He was a member of the panel of the Board of Inventions and Research from its inception, and in 1916 undertook the task of directing the acoustic work on submarine detection, which was carried through with such success. After the War he took up his professorial work at University College, but post-war conditions made the establishment of an active laboratory difficult. Good work was done, with which the names of Müller and Shearer must be associated, but in 1923, before Bragg had had time to become identified with University College, he was appointed to the directorship of the Royal Institution and of the Davy Faraday Research Laboratory.

This was in every respect a happy appointment. At the Royal Institution Bragg had full scope both for his wonderful gifts as a popular exponent of science and for his leadership in original investigation. The first Christmas Lectures which he delivered, "The World of Sound", at once made it clear that the Faraday of "The History of a Candle" had found a worthy successor. His Friday Evening Discourses gave delight to an ever-growing circle. At the same time his very broad interests—Bragg was a keen lover of music, as Mr. Mark Hambourg was reminding me recently; he was widely read; and as a young man he painted and drew with considerable skill—and his personal charm enabled him to attract to the Institution a wide variety of distinguished lecturers. His family, too, identified itself with the Institution. Until her death in 1929 Lady Bragg took a very active part in all its social life, and since then Bragg's daughter, Mrs. Alban Caroe, has played the hostess with great tact and charm; while Sir Lawrence not only delivered a set of Christmas Lectures and various discourses but has, since 1938, been professor of natural philosophy there. Bragg loved the Royal Institution and took the keenest interest in its traditions and history. He played, for example, a prominent part in the publication of Faraday's Diary.

Many honours came to Bragg from all parts of the world. In 1915, he, with his son, was awarded the Nobel Prize for physics for the work on X-rays and crystal structure. In 1931 he was admitted to the Order of Merit. From 1935 until 1940 he was president of the Royal Society, an office which he filled with conspicuous charm and unaffected dignity. He was awarded the Rumford and the Copley Medals. Through all these distinctions he retained a modest and chivalrous outlook, in which seriousness of purpose was balanced by a deep sense of humour, deep religious feeling by a complete lack of bigotry. His family life and his public life were serene, cheerful and complete. The end was sudden. His heart had troubled him for some time. On Tuesday he had to take to his bed and he died on Thursday, March 12.

E. N. da C. Andrade.

There are men of science one cannot help admiring without liking them overmuch, and there are others one likes while secretly thinking them misguided: to few is it given to be both loved and admired. Sir William Bragg was one of those few—more than that, he was said to be the best-loved man of science in the world. One just wanted to do things for him, and do them well. He was that kind of a man.

The story of the latter part of Bragg's scientific life is, of course, the story of structure analysis: he was not an active participant in everything, naturally, or the originator of every new idea, but he was the soul of everything. We who were his disciples and are his apostles had always the impulse to "tell Bragg about it" wherever we were working, for we knew that we could talk to him, that he would listen, and that he would be just as thrilled as we were. In the laboratory he would run to us just the same to tell us of any new idea that had occurred to him. He had a very human desire to share his joy, his boyish glee, and to be told that it *was* a good idea. His face would sometimes fall quite like a boy's if (very rarely!) you happened to think it was not a good idea after all—but you could always argue peaceably with him; he was your pupil just as much as you were his. That, added to his great kindliness and modesty, was, I think, the secret of Bragg's influence. There was no question of his making regular tours to discuss progress; but he might pop into your room any time to tell you something or ask you something, and it was your pride to be able to talk intelligently about the one or to answer the other.

When in 1921 I had the good fortune to become one of Bragg's assistants at University College, the first exciting days were over in which he and his son founded crystal analysis and X-ray spectroscopy, and he was turning his mind more to space-groups and organic crystals. At that time he was not really conversant with space-group theory—none of us were—for he was a physicist first and a crystallographer by implication, but he and his son had already demonstrated the laws experimentally. If I am asked to convey in a word all that the Braggs in those earlier years did for crystallography, quite apart from their stupendous contribution to spectroscopy and diffraction theory, I like to tell this story, based on the fact that nowadays straight crystal analysis runs so smoothly that it has become difficult to believe that there were once birth pangs and growing pains. There was put to me some such question as this: "Tell me, what was all this business about sodium chloride? From the theory of space-groups and a little common sense the thing could scarcely be anything else but O_h^5. You can work the whole thing out simply from atomic weights, the density and Avogadro's number. What *did* the Braggs do with sodium chloride?" To which I could not help replying, "Oh, they just proved the theory of space-groups, that's all."

Soon after the War of 1914–18, as I say, Sir William's mind became engrossed with the shapes, sizes and distribution in crystallographic space of the larger non-ionized molecules of organic chemistry, and in this field he broke first ground with that splendid investigation of the structures of naphthalene and anthracene. Not that he ever abandoned inorganic crystals or loved them any the less—witness, also about that time, what to my mind is one of the most beautiful things he ever did, the structure of ice; or his later return to quartz to explain so elegantly its modes of twinning. But he tended more and more towards organic structures, not merely as a convenient division of labour with his son's school at Manchester, where giant strides were being continued in the inorganic field, technique and diffraction problems, but also because at heart, besides being by implication a crystallographer, he was by induction a biologist, a molecular biologist. When we went to the Royal Institution in 1923 and set about helping him to re-found the Davy Faraday

Laboratory, he not long after gave a series of lectures on the "Imperfect Crystallisation of Common Things" (reported in one daily paper as the "Imperfect Civilisation of Common Things"!), and it was my privilege to provide X-ray photographs of hair, cotton, bone, sea-hedgehog spines and such-like —pretty dreadful photographs they were too, as we know now, but none the less precious, because of their associations. I would say that dating from that time Bragg saw, and saw more clearly with the passing years, that the crowning glory of structure analysis would one day be in the realms of biology. It was granted to him to live to see this dream beginning to come true in the work of his own pupils.

Those were great days when he re-made the Davy Faraday, and we all had our chosen tasks building with him—X-ray tubes and spectrometers, long-chain compounds, space-groups, basic beryllium acetate and other fascinating co-ordination compounds and organic crystals, X-ray photometry, the theory of rotation photographs, and all sorts of lovely things. Bragg himself was too busy with other duties to stick to any continuous line of research, but he lectured about all that was going on (and about much, besides, that was outside X-ray analysis), thereby revealing ever-new points of view, and from time to time he would dash back into the fray to thrash out something that had excited his eternally boyish interest. He had the most amazing faculty of taking up a subject on which he had only the foggiest ideas to begin with, and quickly improving it out of all recognition; as, for example, at the Faraday Society's discussion on "Liquid Crystals" held at the Royal Institution in 1933, when he explained the optics of smectic substances in terms of the cyclides of Dupin; and often, if you met him a few weeks afterwards, he would have reverted, not indeed to his initial fogginess, but to a state of comparative forgetfulness, just because he was pre-occupied doing the same sort of thing in some other line.

As a lecturer and writer he was pre-eminent, as everyone knows. I should say that he was the most charming and lucid scientific writer of our time. Is there anything in all scientific literature to equal the opening sentence of his "Universe of Light": "Light brings us news of the Universe"? And who among our men of science could have matched his article in *The Times* on the nation's food that he wrote at the age of seventy-eight? But one cannot even begin in this brief homage to show all the man that Bragg was. To many, like myself, he was a scientific father. Simply and affectionately we called him "The Old Man". W. T. ASTBURY.

It is seldom that the death of a leader in science brings so deep a sense of intimate and personal loss to people of all ages and conditions, as does that of Sir William Bragg. From his own contemporaries and colleagues down to the children, for whom he loved to exploit his wonderful faculty of simple presentation, everyone feels that, with this departure of another of the great ones of a great period in science, a dear and familiar friend has gone from us.

Nowhere will the loss of him be more constantly or more keenly felt than in the circles of the Royal Society. Living at the Royal Institution, a short walk from Burlington House, he was within easier access to the Royal Society and a more frequent visitor there than other presidents of recent years. It would have been impossible to miss the signs of his influence on the Society, and of his activity on its behalf during his presidential term. Bragg's period of office had seen the gathering and breaking of the storm, and he had early foreseen that Great Britain and its Government would need science as never before. He had steadily and patiently brought to bear the whole weight of his reputation and the strong influence of his personality, so impressive in its wisdom and so charming in its gentle modesty, to ensure that the voice of science should be heard, and that the Royal Society should take its place as the most widely representative of the spokesmen. The appointment of the Scientific Advisory Committee to the War Cabinet, with three officers of the Royal Society as members *ex officio*, was announced during his last year of office, and greeted by him in his last anniversary address to the Society.

The War brought him other duties also, as chairman of the Advisory Committee to the Cabinet on Food Policy, and in many other directions. Some of these duties he laid down with the presidential office, but we were eager to keep him in consultation and still to have the benefit of his wisdom and experience, wherever possible. I hope that we did not keep him at work too long; for, though he had found it necessary to limit his physical effort, he remained so alert, so quick in understanding and so clear in his memory, that it was difficult to think of old age in connexion with him. For two months from Christmas, when I had to go away on other duty, he came back to the presidential chair; and so he remained, quietly at work and ready to give a helping hand anywhere, right up to the few days of illness which brought the end—the close of a long life of whole-hearted devotion to science and to the interests of his fellow-men. H. H. DALE.

By the death of Sir William Bragg, British science loses its most distinguished physicist, while a much wider section of the nation loses also a friendly guide who interpreted the results of science to them with great lucidity and charm. Sir William Bragg's work in furthering the application of science in both Government and industry may not, however, be so widely known and appreciated.

Throughout his life, and particularly in his later years, he saw ever more clearly how the practical applications of scientific work were becoming first the luxuries and then the necessities of human life, and realized that, in consequence, only by organized and appropriately directed scientific research could any industry serving the community continue to thrive. He always advocated, too, the need for the greater incorporation of the results of science in national affairs, but warned us that "it is science itself, not scientists, that we are trying to lift to the high places. . . . We do not claim that scientists shall be entrusted with authority because they are scientists: we do claim that authority shall be exercised in the light of a knowledge which grows continuously and with continual effect on politics, on industry, and on thought itself."

Sagely he added: "If we, in the continually increasing contacts of scientists with current affairs, can show that we have something of great value to contribute and that we give it freely, placing our individual interests below those of a greater purpose; if we try to understand the motives and principles of those whom we meet who may not share our vision, just as we may fail to appreciate theirs, then by so doing we have the best chance of bringing about the changes that we desire."

The contacts of this kind which he personally established were wide and numerous. During the War of 1914–18 he acted as a scientific adviser to the Admiralty, devoting his attention to the problem of submarine detection. During the present War he has been frequently consulted on a variety of scientific matters and has been chairman, since its formation, of the Committee advising the War Cabinet Food Policy Committee on scientific aspects of war-time food problems. He has also been a member since its formation of the Scientific Advisory Committee established under the chairmanship of Lord Hankey. As he himself pointed out, the significant feature of these committees was their close and direct association with the Cabinet, so that scientific advice was brought into Government at the highest possible level.

It was the same appreciation of the place of science in everyday life and in industry that led him to accept appointment to the Advisory Council of the Department of Scientific and Industrial Research, of which he was still a member at the time of his death. But he counted his duties as a member of this body insufficiently discharged in the formal business of meetings, and the young men of science in both the Department's own stations and in the laboratories of the research associations will long remember his heartening and inspiring visits, when the distance between senior and junior magically vanished and both hopes and difficulties were shared.

Edward Appleton.

Every journal devoted to scientific learning has been deprived of an unfailing source of light and leading by the death of Sir William Bragg; but none can have benefited more than Nature from his wisdom and judgment. It is with a full and grateful heart that I remember many occasions when he readily gave guidance upon subjects in which his special knowledge as well as his wide interests were of particular value, and when his contributions to its pages enlightened the readers of this journal. With a diffidence which was natural to him, he often suggested, when asked for copies of addresses or lectures delivered by him, that he doubted whether Nature would find much in them suitable for publication, though his printed words were always as highly appreciated as his spoken utterances and the light of them penetrated to a much greater distance than the sound.

Sir William Bragg's first communication to Nature was in 1908, and its subject was the nature of γ- and X-rays. He was then at the University of Adelaide and had entered the new and wonderful field of physics opened by the discovery of radioactivity and the isolation of the electron. In the following year he became Cavendish professor of physics in the University of Leeds, and a year or two later I induced him to prepare a monograph bringing together, under the title of "Studies in Radioactivity", methods and results of investigations of the phenomena attending the passage of the new types of radiation through matter. This monograph was the first of his published books. As editor of the series to which the volume belonged, I was able to make a few suggestions upon its scope and structure, but with the characteristic generosity shown to all associated with him in work of any kind, Sir William referred to me at the end of the preface in the words: "He has been most kind in allowing me to benefit by his experience. He set me my task, but he has done his best to make it an easy one."

Our friendship began with the production of this volume thirty years ago, and throughout this period I have followed with fraternal affection the leading part played by Sir William in the renaissance of modern physical science through the development of his pioneer studies. It would be presumptuous for me to praise the insight and the ingenuity which he used to reveal regularities of arrangements of atoms and molecules by the method of X-ray analysis; but with all his friends I share personal pride in his great achievements, and thankfulness that his son, Sir Lawrence Bragg, remains with us to continue to explore this fertile field.

By their individual and joint researches, what began as an academic study soon extended into the fields of applied science and has now become a subject of prime importance in the understanding of many industrial processes. They have enabled us to see and trace patterns in the structure of matter previously beyond the sight of man though not beyond his imagination. In one of his sonnets, Michael Angelo beautifully expressed the similar function of a sculptor to unfold a form hidden in a block of marble, in the words:

> The very sculptor can no thought conceive,
> That does not lie deep buried in the stone.
> And this, the eye discovereth alone,
> That doth commandment from the mind receive.

Just as light becomes visible only when it impinges upon matter, so natural knowledge has to be perceived before it can produce enlightenment. Sir William Bragg was not only a rich source of such knowledge, but also the creator of waves of thought with which every intelligent mind could make appreciative contact. His style of exposition was effective because it was simple and unpedantic in scientific substance or literary embroidery; and his messages appealed, therefore, to all classes of the community. He was an acknowledged master of scientific craftsmanship in a field of work to which he devoted the greater part of his life, and also a creator of designs and a convincing exponent of their beauty. With the desire for truth always in his heart, and the pursuit of it in the domain of verifiable knowledge as the purpose of scientific inquiry, he combined wise counsel and the might of understanding, and has bequeathed to the world a splendid heritage to be treasured with affectionate memory.

R. A. Gregory.

The loss of Sir William Bragg will be felt by physicists all over the world. His rare combination of experimental skill with lucidity of thought and pre-eminent clarity of exposition would have marked him as an outstanding figure in any generation. But he will be remembered among his many friends almost more for his kindliness and charm, especially to the younger generation. He was always ready, as I know from my own experience, to discuss any problem, even with a young undergraduate, on equal terms. Argument and contradiction never ruffled him. Even when he appeared to be caught out by some contradiction, such as were only too easy to construct in the days when we were all fumbling for the explanation of the quantum paradoxes, his serene imperturbability was never disturbed. All the scientific honours heaped upon him made not the slightest difference to his modest and unassuming manner and address. He was a man who can never have had an enemy and who has left an abiding mark in the memory of his innumerable friends.

CHERWELL.

THE late Sir William Bragg's wide influence upon contemporary science is universally acknowledged. It was always his desire that men of science should throw aside the cloak of mysticism and seclusion and appear as other men striving after truth in no matter what field of action. This view has recently acquired especial significance because of the great service to the State which science, when properly applied, is now generally seen to be capable of giving; and it was this attitude of mind that largely prompted his delight in simplifying, so far as possible, for the benefit of others many of the highly complex problems of physics with which his name is so closely connected. Thus his lectures were remarkable for their clarity and experimental illustration. The underlying motive was always to let others see and understand what his own clear vision could discover.

The Royal Institution afforded ideal facilities for research and exposition, which exactly suited Bragg's temperament. He showed in many ways how deeply he felt the honour and responsibility of following in the footsteps of Faraday. Sir William's versatility was particularly noticeable in the courses of Christmas Lectures to Children, which he delivered in 1919–20 upon "Sound", since it was then that his interest in music suggested many ingenious illustrations. For the series he gave in 1931–32 he chose "Light" as the subject and dealt fully with the nature of colour and colour mixtures. In this connexion it may be pointed out that during the last meeting of the British Association at Cambridge, an exhibition of pictures by members was arranged, and there Sir William showed several charming water-colour landscapes which he had painted when abroad. His Christmas Lectures were memorable occasions for many reasons, because the presence of children always stimulated in him those fascinating qualities of friendliness and enthusiasm which were a dominating characteristic of his nature. His quick mind often enabled him to make a witty reply to a question, but it never wounded.

After each of the Christmas lectures there were delightful tea parties in Sir William's private rooms.

We, at the Royal Institution, deplore the loss of one whose guidance in all affairs was so invaluable and fair-minded. We cherish the memory of his invariable courtesy, kindliness, enthusiasm and loyalty to the great traditions of his calling. He was beloved by all.

CHARLES E. S. PHILLIPS.
(Hon. Sec. Royal Institution.)

IN the death of Sir William Bragg we lose a great man and well-tried friend; and, distinguished as have been his services to science and to the State, it is the sense of personal loss, the tribute to his rich human qualities, which now dominates. The loss was so completely unexpected; age had not withered him; his wide and generous knowledge was ready to hand and at the service of all real inquirers; his interests were as fresh as ever, and his unique power of lucid exposition seemed to grow greater as time passed this tract on electromagnetism, which saw the light but a month or two since, is a model of its kind).

His pioneer contributions to physical science have provided a probe for the scrutiny of the submicroscopic world and, equally with these investigations, his faculty for seizing on essentials, for reducing a complex problem to its simplest elements, for describing physical phenomena with incomparable clarity and charm, made him a most fitting head of an institution the traditions of which are so intimately associated with the names of Davy and of Faraday.

A little incident comes to mind which may serve to illustrate these qualities. A paper was read before one of our societies by a young investigator who, with the blundering particularity of youth, insisted on describing methods and results with such indiscriminating zeal and detail, that his audience was left completely befogged. Perfunctory applause had died down, when Sir William rose, and in a five-minute speech gave a masterly sketch of the paper, which showed it for the sound piece of work that it was, cleared the mists from the minds of his hearers, and left the author heartened and encouraged.

Friendliness and helpfulness were of the essence of his being; and though institutions may remain, while those who direct their activities come and go, it is difficult to think of the Royal Institution without Sir William's friendly presence, guiding and leading the researches of the laboratory and informing the work of the Institution with the spirit of Faraday.

May his memory long be kept green!

ALLAN FERGUSON.

THOUGH it was a great pleasure to meet Sir William Bragg anywhere and on any occasion, it is on his own ground at the Royal Institution that most of us best remember him. The setting so became him; and he so graced the setting. Whether receiving the guests on a Friday evening, or expounding some of the mysteries of science in the great lecture theatre, or merely entertaining some stray scientific visitor to tea, Bragg had the art, which was no art because it was rooted in real interest and a genuine affection for humanity, of making the visitor feel at home. Any scientific society which might have been fortunate enough to obtain the privilege of holding a meeting in the Institution would usually find on arrival that the Director, by some happy chance, had business which took him into the entrance hall, and the visitors would receive from him friendly informal greetings which made them feel that they were not intruders, but welcome guests. In the work and welfare of the younger generation of men of science Bragg's interest was almost paternal.

In his early work Bragg made some fundamental contributions to the science of radioactivity. He was, I believe, the first to point out that gamma rays and X-rays behaved, in many respects, like uncharged particles: an idea with which modern quantum theory has now familiarized us. His remarkable work on the elucidation of crystalline structures by X-rays, carried out in collaboration with his son W. L. (now Sir Lawrence) Bragg, has founded a new branch of science, and has forged a new and valuable weapon in the armoury of industrial research. X-ray analysis is now being applied to the study and improvement of an amazing variety of commercial products.

As an interpreter of physics to the public Bragg was unrivalled in the present age. His discourses at the

Royal Institution, illustrated with all the resources at its command, were a sheer delight. Simple yet profound, the non-scientific hearer could gather a clear mental picture of the subject discussed, while the professional man of science enjoying the apparently effortless artistry of the presentation usually found that, in addition, he had gained some quite new side-lights on a subject with which he had thought himself completely familiar.

J. A. Crowther.

Nearly twenty years ago, as a young graduate, I joined the team of research workers at University College, London, who were inspired and led by Sir William Bragg. His was a charming personality and he was an ideal research professor. Keen on his own work, bubbling over with enthusiasm at each new discovery; just as interested in ours, yet never obtrusive, never impatient. We knew that he shared our joy at each idea proved correct, because he himself had such an astonishing intuition. He knew where to look for knowledge; but although intuition showed him the way, he was never satisfied with less than the most complete proof that the knowledge attained was fundamentally sound. An admitted mistake found him sympathetically understanding; like Faraday, he never regarded time as wasted if it increased experience. Yet he could be stern on occasion: a young man who spoke slightingly of one whose lifetime had been spent in determining one physical constant really accurately was most surprised to receive a sharp rebuke. Such painstaking and unspectacular labour Sir William knew to be the very cornerstone of research.

Sir William attracted and welcomed to the laboratories of the Royal Institution workers from all parts of the world, and most of them must remember with gratitude not only the opportunities for scientific research and discussion thus afforded but also, and perhaps not least, the delightful garden parties given at his country cottage at Chiddingfold. Those of us who are still working on the problems that enthralled him to the last, feel that we have lost not only a leader but also a personal friend.

Kathleen Lonsdale.

NEW FELLOWS OF THE ROYAL SOCIETY

The following were elected to the fellowship of the Royal Society on March 19:

Prof. J. H. Burn, professor of pharmacology, Oxford, formerly dean of the College of the Pharmaceutical Society; distinguished for his work in physiology and pharmacology and on the principles and methods of biological standardization.

Dr. F. M. Burnet, assistant director of the Walter and Eliza Hall Institute for Medical Research, Melbourne; distinguished for his researches in bacteriology, especially on avian and mammalian viruses.

Dr. M. Dixon, lecturer in biochemistry, Cambridge; distinguished for his work on tissue respiration and respiratory catalysis.

Prof. E. C. Dodds, M.V.O., professor of biochemistry, Middlesex Hospital Medical School; distinguished for his investigations in biochemistry in relation to physiology and medicine and especially in the synthetic production of œstrogenic agents.

Mr. A. Fage, principal scientific officer, Aerodynamics Department, National Physical Laboratory; distinguished for his contributions to the experimental study of aero- and hydro-dynamics, particularly in relation to turbulent flow.

Colonel N. H. Fairley, A.A.M.C., consulting physician in tropical diseases, director of special research, Hospital for Tropical Diseases, London; distinguished for his researches in tropical medicine.

Mr. P. Hall, university lecturer in mathematics, Cambridge; distinguished for his contributions to pure mathematics, particularly in the theory of groups.

Prof. G. H. Henderson, professor of mathematical physics, Dalhousie University, Halifax, Nova Scotia; distinguished for his work in radioactivity and particularly in the investigation of pleochroic haloes.

Prof. T. P. Hilditch, professor of industrial chemistry, Liverpool; distinguished for his work on the chemistry of natural fats.

Prof. E. Hindle, regius professor of zoology, Glasgow; distinguished for his work in parasitology, and on the cytology of artificial parthenogenesis.

Dr. C. S. Hanes, senior scientific officer, Low Temperature Research Station, Cambridge; distinguished for his researches in botany and biochemistry, especially the first enzymatic synthesis of starch.

Prof. A. Holmes, professor of geology, Durham; distinguished for his work in petrology and the applications of radioactivity to geological problems.

Prof. D. M. Newitt, assistant professor of chemical technology, Imperial College, London; distinguished for his work on high-pressure technology and for his researches on combustion.

Dr. C. C. Paterson, O.B.E., director of the Research Laboratories, General Electric Company, Wembley; distinguished for his work in promoting physical and industrial research.

Dr. J. K. Roberts, assistant director of research, Colloid Science Laboratory, Cambridge; distinguished for his investigations by physical methods on adsorption and other surface phenomena of importance in catalysis.

Dr. H. W. B. Skinner, Wills research fellow and lecturer in spectroscopy, Bristol; distinguished for his work on the X-ray spectroscopy of the solid state, leading to results of importance in the theory of the structure of metals.

Prof. D. Thoday, professor of botany, Bangor; distinguished for his researches in plant physiology, particularly those dealing with photosynthesis, causal anatomy and the water relations of plants.

Prof. A. R. Todd, professor of chemistry, University of Manchester; distinguished for his researches in organic chemistry, notably the synthesis of vitamin B_1 and other natural compounds of physiological importance.

Prof. A. E. Trueman, professor of geology, Glasgow; distinguished for his work in palæontology, particularly on molluscan faunas of the coal measures.

Mr. A. H. Wilson, university lecturer in mathematics, Cambridge; distinguished for his contributions to the electronic theory of solids and for his work on the properties of metals.

NEWS and VIEWS

Tributes to Sir William Bragg

Elsewhere in this issue, a few of the innumerable friends of Sir William Bragg, and representatives of bodies concerned with the various phases of his activities, pay their tribute to him. In particular we would endorse Sir Richard Gregory's reference to Sir William's services to Nature; and we may add that his wisdom and advice, given in characteristically kindly and modest manner, remained at our disposal right up to the end. His abiding interest in crystal analysis was reflected in a communication published in Nature of December 27, 1941, p. 780, on the problem of the diffuse spots in X-ray photographs.

At the memorial service in Westminster Abbey held on March 19, a great company of those who had been associated with Sir William during the course of a long life of service in the cause of science showed by their presence the honour in which he was held. H.M. the King was represented by Earl Fortescue, the president of the Board of Education attended, and scientific societies and Government Departments were represented by their officers. The Archbishop of Canterbury and the Dean of Westminister took part in the impressive service: the Lesson was taken from I Corinthians, xiii, concluding with the words, "the greatest of these is charity"—surely an apposite phrase to associate with Sir William Bragg's memory. Prof. E. N. da C. Andrade has ably summed up Sir William's many-sided character in verses he wrote as a dedication to his book "Engines"; we quote these lines:

You, by a twofold excellence
Raised to deservèd eminence,
Not only Nature can compel
Her enigmatic oracle
To breathe to you, but can convey 't
Clear to the uninitiate.

. . . .

Three times yourself at Christmastide
Have charmed us as the children's guide,
In ice and snow's fantastic frond
And close-compacted diamond
Have shown the wonders that abound,
And wandered through the World of Sound:
And have most curiously displayed
How science guides the hand of trade.

Dr. J. de Graaff Hunter, C.I.E., F.R.S.

News has been received from Sir Gerald Lenox-Conygham of Dr. J. de Graaff Hunter, formerly director of the Geodetic Branch, Survey of India, who is a prisoner in Germany. Dr. Hunter had gone to California to represent Great Britain at the Pacific Science Congress which was to be held there in September 1939, and it had been his intention to spend the winter there; his wife and daughter were with him and it was thought that the climate of California would be good for his daughter's health. When war was declared, he found himself unable to obtain money from England and was obliged to move to some place in the 'sterling' area. He thought of Jamaica, but eventually decided on Nassau in the Bahamas. He had in the meantime written to the Surveyor-General of India offering to return to India to serve in his old department in any capacity; and after some considerable time, he learned that he would be welcomed back in India. Dr. Hunter then went from Nassau to New York, intending to take ship to Cape Town and after arrival in Cape Town to plan the remainder of the journey. He accordingly sailed from New York in the steamer *Zam Zam* on March 15, 1941. This ship was attacked and sunk by a German raider when she was about three days from Cape Town. The passengers were put on board a supply ship and were at sea in her for a long time. Eventually they were landed at a port near Bordeaux and were conveyed by slow stages to internment camps in Germany. Dr. Hunter's address is: Gefangennummer 102872, British Civilian Internee, Ilag VIII, Deutschland; Mrs. Hunter and her daughter are at Interniertenlager, Liebenau, Würtemburg. Letters are being received both from Dr. Hunter and from Mrs. Hunter, from which it appears that they are tolerably well.

Breeding of Mosquitoes in Static Water Supplies

The Limmer and Trinidad Lake Asphalt Co. Ltd., has issued a memorandum of notes on mosquitoes breeding in static water supplies. It is written by J. F. Marshall, director, British Mosquito Control Institute, in collaboration with K. W. Attwooll, chief chemist to the above-named company. From among the thirty different species of mosquitoes known to inhabit Great Britain, only *Culex pipiens* is at all likely to breed in ordinary water-storage tanks. It is, furthermore, a species that rarely or never bites man. Two other species, namely, *Theobaldia annulata* and *Culex molestus*, occur in such tanks under special conditions only. The first-named breeds almost exclusively in water fouled through contamination with sewage or other nitrogenous matter. *C. molestus*, on the other hand, appears to select water located in dark underground places such as basement-stored water. It is pointed out that static water supplies in open-air tanks need never be changed or treated from October until March inclusive since *Culex pipiens* is then in hibernation. At other times treatment need only be applied when necessary to allay public apprehension of the presence of breeding mosquitoes. In so far as the other two species are concerned, any larvicide used should be non-injurious where asphalt or bituminous rendering has been employed for water-proofing purposes. This means that oiling of the water is undesirable; also it is deleterious to the rubber of stirrup pumps, etc. Disinfectant fluids of the nature of coal tar derivatives are harmless in the above connexions and at the same time effective larvicides at about one part in 28,000–50,000, according to circumstances. Their use is therefore preferable and to be recommended.

Entomology of Commerce

At the annual general meeting of the Society of Public Analysts and Other Analytical Chemists held on March 6, a lecture on "The Entomology of Commerce" was delivered by Prof. J. W. Munro, director of the Biological Field Station, Imperial College of Science and Technology, Slough. After a brief description of the main types of insects responsible for damage to foodstuffs and other materials, Prof. Munro mentioned some instances in which the ravages of certain insect pests have been traced to economic causes; for example, troubles from wood-boring insects due to importation of long-stored timber, and appearance of new types of infection in tobacco due to certain importations from Africa. Combating insect pests by cleanliness and rigorous control of storage conditions may suffice with materials initially sound, but is inadequate with materials imported in a highly infected condition. Work on this subject is being carried out at the Biological Field Station at Slough. Destruction by heat has been employed against wood-boring insects. Low temperatures are used in the tobacco trade; the resistance depends on the rate of cooling, and improved results have been obtained by a second cooling after an intermediate warming. Studies of the insecticidal action of some inert powders have given promising results; the action appears to be due to withdrawal of moisture. In discussing chemical insecticides that act in vapour form, Prof. Munro directed attention to the influence of various factors, such as temperature, and inequalities of distribution, and gave some results obtained in studying them. Investigations are in progress to elucidate the mechanism of insecticidal action and so to ascertain what properties are necessary in an insecticide to enable it to penetrate the epicuticle and cell-walls of an insect and upset the normal processes within.

National Astrophysical Observatory of Mexico

A NUMBER of distinguished scientific men from both North and South America took part in the Inter-American Scientific Conference held in Mexico during February 15–26, on the occasion of the dedication of the new National Astrophysical Observatory of Mexico. President Manuel Avila Camacho, of Mexico, in issuing invitations to the conference, said: "The purpose of the Mexican Government is to contribute to the maintenance, in the American continent, of the progress of science and culture, and thus counteract as much as possible, the paralysation of scientific and cultural activities in the countries devastated by war". The new Observatory is situated on land provided by the Government of the State of Puebla, near a small town of Aztec origin called Tonanzintla, about 80 miles east of Mexico City. Under the direction of Prof. L. E. Erro, observations of the southern Milky Way will be made with a 24–30-in. Schmidt camera, the most powerful telescope in the tropics. This instrument will be similar to the Jewett telescope at Harvard Observatory, and its mounting is at present under construction in the Harvard shops. Its location in lat. 19° is of great importance for studies of the southern skies, which are inaccessible to instruments farther north. The climate is excellent for observation, especially during the winter. The programme of the Observatory includes variable-star studies, and observations of meteors and the sun.

Carnegie Trust for the Universities of Scotland

THE fortieth annual report of the Carnegie Trust for the Universities of Scotland covers the academic year 1940–41, and includes details of the interim distribution of grants, the endowment of post-graduate study and research, assistance to students and an abstract of financial accounts for the year ended September 30, 1941 (Edinburgh: Carnegie Trust for the Universities of Scotland). Of the three who were elected to fellowships at the beginning of the year, two are still working in universities, and of the nine awarded senior scholarships, five (of whom four were women) completed the session's work. Of the forty-five scholars elected at the beginning of 1940–41, nineteen resigned immediately upon appointment or requested that their scholarships be suspended on account of war service. Of the thirty-five fellows, senior scholars and scholars elected in July 1941, thirteen have similarly asked that their awards be held in suspense, while three others were unable to accept owing to war work.

Reference is made in the course of the report to Dr. Webster's and Mrs. Hickie's work on the synthesis of compounds of possible value as anti-malarials, and to R. R. Coats's investigation on the interconversion of aromatic sulphonic acids and sulphones and on syntheses of sesquiterpene derivatives. J. Forrest has synthesized certain complex hydrocarbons and thrown much light on the reactions of fluorene, while A. B. Grant's work on the chitin of crab-shell has advanced our knowledge of chitose. Mention is also made of the work of Dr. W. Tebrich and Dr. J. M. Robson on the degree of penetration of sulphonamide compounds into the ocular tissues of rabbits when they are superficially deposited on the eye (see NATURE, Dec. 6, 1941, p. 695) and of Dr. J. D. Loudon's work on the mutual effect of substituent groups in benzene derivatives. The decrease in the assistance to students, amounting to 171 beneficiaries, was mainly among male students in the faculties of arts, law and divinity.

Biological Research in China

THE latest issue of *Sinensia* (2, No. 5–6, September, 1940) that has come to hand will be found an encouraging record of good work from the National Institute of Zoology and Botany, Academia Sinica, Peipah, Szechuan (China). With one exception the twelve contributions that go to make up the issue are the work of Chinese investigators. From the zoological point of view the most important papers are by Sicien H. Chen on leaf-beetles (Family Chrysomelidæ). This author proposes to raise the six sub-families that form this group to the status of separate families. This change implies that each of these families would become of the same taxonomic significance as the well-established families Cerambycidæ and Bruchidæ in the superfamily Phytophaga. In a second contribution the same author contributes extensive "Notes on Chinese Eumolpidæ", which deal with their classification and include descriptions of a number of new species. From the botanical side S. H. Ou's "Phycomycetes of China" (II) is a notable and well-illustrated paper. S.C. Teng's "Studies on Chinese Timber Trees in reference to Forest Management" (I) is a timely investigation now that the forests of China have come to a stage when they require systematic management.

Universities' Federation for Animal Welfare

THE fifteenth annual report of the Universities' Federation for Animal Welfare (UFAW) reports continued activities in its educational and research work; but as few students of the University of London are now in London college activities have been temporarily discontinued. More than six thousand copies of the Federation's new natural history lecturettes have been contributed at cost price to local education authorities. Much work is being done on the humane side of mole- and rabbit-trapping, and authenticated information is being collected from biologists. UFAW is not in entire agreement with the Ministry of Agriculture's war-time rabbit-trapping arrangements in allowing steel traps to be set in the open, and prefers the rabbit to be exterminated as a pest and not preserved for the trapping industry. It disagrees with recent attempts in rural circles to re-stock warrens that have been exterminated in the war-time rabbit campaign. The Federation has recently issued a leaflet directing attention to the condition of the Canadian beaver, noting that more than fifty thousand beavers a year have recently been trapped in Canada. It plans to promote Parliamentary bills to prohibit the sale of rabbits mutilated by gin trap or snare, and to prohibit the sale and manufacture of gin traps. Its Bill to prohibit the setting of gin traps in the open and making rabbit extermination compulsory became law in 1939.

Lice

UNDER the title "Lice" the British Museum (Natural History) has added another pamphlet to its Economic Series (1942). The author, Dr. John Smart, gives a very clearly written account of these creatures affecting man, including their life-history and how infection takes place. A short statement regarding louse-borne diseases is also included and there is a useful section dealing with the prevention and treatment of lousiness. The pamphlet is well up to date and includes some of the most recently acquired information. In its thirty-two pages are comprised all the essential facts likely to be required by non-technical readers. It can be obtained from the Museum or through a bookseller, price 6*d*.

Geophysical Institute of the Andes

THE Geophysical Institute of the Andes, just inaugurated in Bogota, Colombia, at the new Colegio de San Bartolome, is the most important one in South America, the only one in Colombia, and one of eight under the Southern Cross. It is directed by two Jesuits, the Rev. Simon Sarasola and Jose Ramirez, the latter a graduate in seismology at St. Louis. The seismological station is about 8,745 ft. above sea-level, and half-way up the Andes del Norte.

The Hebrew University, Jerusalem

Two hundred and ninety-five students have graduated at the Hebrew University, Jerusalem, during the last eleven years. 90 per cent of them have found employment of a nature permitting them to continue their studies in Palestine. Thirteen graduates found occupations abroad, mostly in the United States, and fifty-six continue with scientific and research work in the University itself, in the Hadassah Hospital, the Palestine Government, or other public institutions.

Hermann C. Vogel, 1842-1907.

HERMANN CARL VOGEL, the German astronomer, was born at Leipzig on April 3, 1842. He was the youngest son of Dr. Vogel, a well-known schoolmaster and a brother of Edouard Vogel (1829–56), the African explorer. From the University of Leipzig young Vogel entered Leipzig Observatory and assisted Zöllner in researches on solar prominences. From 1870 until 1874 he was in charge of von Bülow's observatory at Bothkamp in Holstein, where he did spectroscopic work on the sun, the planets, stars and nebulæ. When the German Government in 1874 founded the Astrophysical Observatory at Potsdam, Vogel became one of the assistants, with Spörer and Lohse as colleagues. With Müller he prepared a spectroscopic star catalogue containing particulars of 4,051 stars, and in 1887 with Schreiner began the measurement of the radial motion of stars. He took an active part in the work of the International Chart of the Heavens and in many ways furthered astronomical science. His honours included the Valz Prize of the Paris Academy of Sciences, the Gold Medal of the Royal Astronomical Society, the Draper Medal of the U.S. National Academy of Sciences and the Prussian Order of Merit. He died at Potsdam on August 14, 1907, leaving by his will 17,000 marks to the Berlin Academy of Sciences for the encouragement of research in astrophysics. He had been director of the Potsdam Observatory since 1882, and at his death he was succeeded by Schwarzschild.

Night Sky in April

THE moon is full on April 1d. 12h. 32m. U.T. and new on April 15d. 14h. 32m. Lunar conjunctions with the planets occur as follows: Venus on April 11d. 16h., Venus 0·1° N.; Saturn on April 18d. 05h., Saturn 3° N.; Jupiter on April 20d. 01h., Jupiter 5° N.; Mars on April 20d. 17h., Mars 6° N. On April 4d. 04h. Mars will be in conjunction with Jupiter, Mars 1·7° N., and on April 28d. 09h. Saturn will be in conjunction with Uranus, Saturn 1·6° S. Mars, Jupiter and Saturn are still well placed for observation in the evening. Venus is a morning star and rises about 4h. in the middle of the month. On April 27d. 20h. 15·3m. the star β Virginis, mag. 3·8, will be occulted by the moon. An interesting binary, γ Virginis, has components of nearly equal magnitude, 3·6 and 3·7 respectively; the separation is 5·75″. The Lyrid meteor shower will be active during April 18–22; the radiant is at R.A. 18h., N. Dec. 33°.

Announcements

THE second lecture on the Science and Citizenship Foundation will be given by Prof. Lancelot Hogben at the annual general meeting of the Science Masters' Association, at 8 p.m. on April 9, in the Temple Speech Room, Rugby School, Rugby. The subject will be "Biological Instruction and Training for Citizenship". The lecture is open to the public without fee; tickets may be obtained from Mr. W. Ashhurst, Grammar School, Stretford, Lancs, or from Mr. H. J. Harris, 5, Barby Road, Rugby.

THE Town and Country Planning Association has organized a Conference on Industry and Rural Life which is being held at Newnham College, Cambridge, during March 27–30. Separate sessions will be devoted to agricultural planning and policy, decentralized industry, social life in villages, architecture, rural land-ownership, and design of new towns. Among those taking part are Sir Daniel Hall, Sir Montague Barlow, Prof. Patrick Abercrombie, Mr. L. F. Easterbrook and Prof. Sargent Florence.

ERRATUM.—In the article "The Sun and the Ionosphere" (NATURE, March 7, p. 277), line 9 from foot of Column 1, the word "ultra-violet" should have appeared before "radiation".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Method in X-Ray Crystallography

The classical methods of X-ray crystallography give either the spacings but not the positions of the reflecting planes (if monochromatic radiation is used, as in the rotating crystal and powder methods), or the positions but not the spacings (if white radiation is used, as in the Laue method). X-ray 'goniometers' (Weissenberg, Schiebold-Sauter) give both positions and spacings, but only for one layer line at a time. In what follows a method will be described which gives directly both spacings and positions of the reflecting planes for all diffraction spots in a rotation or oscillation photograph on flat film.

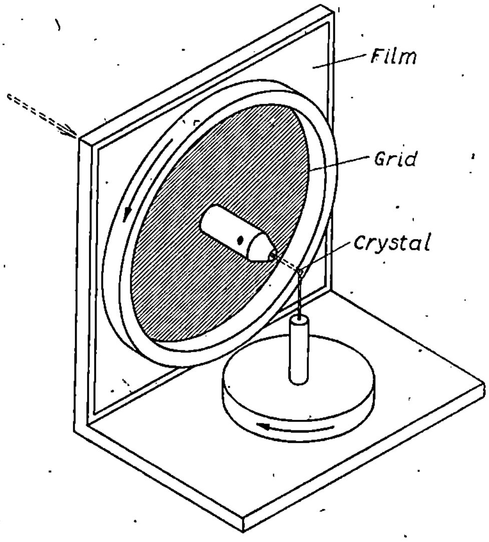

Fig. 1.

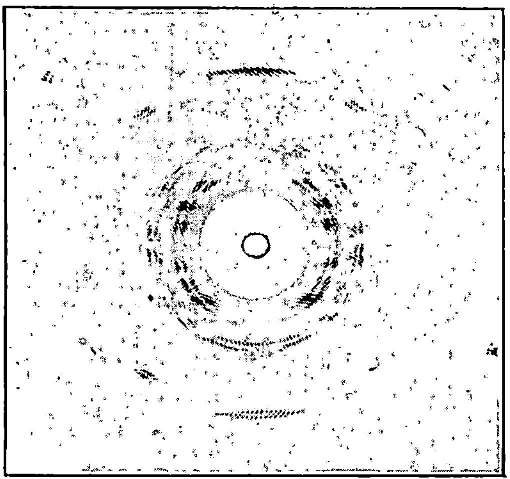

Fig. 2.
CENTRAL PART OF BACK-REFLEXION ROTATION PHOTOGRAPH; NaCl CRYSTAL, COPPER $K\alpha_1 + K\alpha_2$ RADIATION. NATURAL SIZE; DISTANCE CRYSTAL–FILM 28·5 MM.; PINHOLE 1/8 MM.

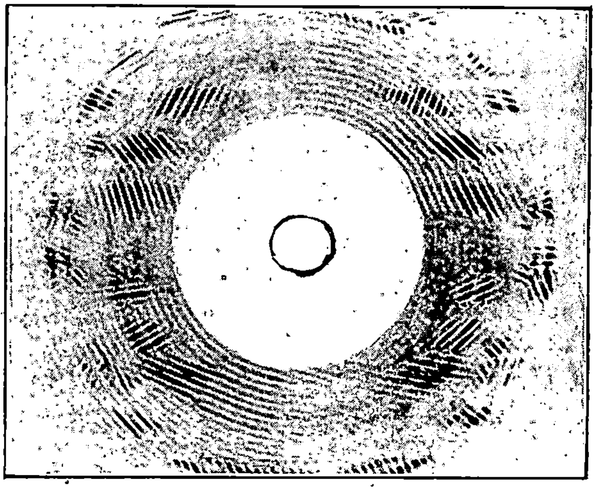

Fig. 3.
CENTRE OF FIG. 2 ENLARGED BY 2·4 DIAMETERS.

The apparatus differs from the usual rotating crystal arrangement only by the addition of a fine grid of thin parallel wires, placed close in front of the film, and rotated in its own plane during the exposure (Fig. 1). The rotation of the grid is mechanically linked with that of the crystal; provided that the total rotation of the grid does not exceed 180°, one position of the grid will correspond to one position of the crystal. The shadows of several wires appear as fine lines upon every diffraction spot (Figs. 2 and 3); they reveal the position of the grid wires and so the position of the crystal at the moment of reflexion. Thus the position of the reflecting planes in the crystal is given by the inclination of the shadow lines, while their spacing is obtained from the position of the diffraction spots by means of Bragg's law.

The photograph shown in Figs. 2 and 3 was taken with a back-reflexion arrangement, shown schematically in Fig. 1; in this case the tube of the pinhole can be used as the axle around which the grid rotates. Crystal and grid were rotated by a synchronous motor with slipless wire drive. The grid was made of copper wires (0·19 mm. thick, 23 wires per cm.) stuck to a strong 'Cellophane' sheet by 'Durofix'. Technical details will be given elsewhere. Fig. 3 is a part of Fig. 2, enlarged by 2·4 diameters; it does not show fully the sharpness of the shadow lines because the enlargement has been much over-exposed in order to make the structure of the background visible (see below). The angles between the shadow lines and a reference line are easily determined by a microscope with turn-table, mechanical stage, and cross-wires in the eyepiece. In the photograph Fig. 2 they could be read off with an accuracy of about ± 0·1°. The method offers a simple and quick way of determining crystal orientations; a detailed communication will appear elsewhere.

Originally, the method was developed for the investigation of internal strains, lattice curvatures, submicroscopic inclusions, and other irregularities which cause the diffraction spots to be drawn out to streaks. In such cases usually neither the classical nor the goniometer methods can reveal without ambiguity the character and orientation of the reflecting elements. The rotating grid method shows directly the positions of the crystal at which the different points of the streak were reflected, and thus provides information about irregularities similar to that provided by the classical methods about regular structures.

Fig. 3 shows that the shadow lines are not confined to the Bragg reflexion spots but often can be followed far into the background. (These straight lines in the background must not be confused with the concentric circles which are a trivial consequence of the rotation of the grid about the central spot.) Consequently, a large proportion of the background in the surroundings of a spot had been reflected simultaneously with the spot. This opens up the possibility of analysing the origin of the background in terms of contributions from individual atomic planes. Part at least of the structure of the background would seem to be due to the 'diffuse' ('dynamic') reflexion of X-rays, caused by the thermal vibration of atomic planes. In a system of shadow lines extending from a Bragg reflexion spot into the background, the dark stripes are produced by the total radiation coming from the crystal, while in the light stripes the radiation contributed by the lattice plane of the Bragg reflexion is screened off. Thus the difference of the intensities represented by the dark and the light stripes at two neighbouring points is the intensity diffracted by the lattice plane of the adjacent Bragg reflexion. This provides a means of quantitative measurements of the diffuse reflexion from individual lattice planes. The photograph Fig. 3, taken at room temperature, shows that the method can be used even at low temperatures, if, by a suitable choice of the radiation, the glancing angle of the lattice plane is brought sufficiently near to 90°.

Another possible use of the new method is for obtaining information about the mosaic imperfections of crystals. If the speed of rotation of the grid, but not that of the crystal, is increased, the contours of the shadow lines must become blurred as the transverse movement of the wires during the time of reflexion begins to be noticeable. If the primary beam is collimated by a perfect-crystal monochromator, this effect should give a direct measure for the X-ray imperfection of the crystal.

I am indebted to Sir Lawrence Bragg and to Dr. H. Lipson for valuable suggestions.

E. OROWAN.

Cavendish Laboratory,
Cambridge.
Jan. 31.

Nitrogenous Character of Penicillin

PENICILLIN purified as described by Abraham and Chain[1] contains nitrogen. The interpretation of low positive results in the Dumas analysis of less pure material was made uncertain by the failure to respond to the usual qualitative test and by low results in Kjeldahl estimations. However, traces of pyridine have been recognized, by the characteristic absorption spectrum, as a product of the action of boiling concentrated sulphuric acid on the purest material. With this material the Kjeldahl method, under vigorous conditions, gave the same result as the Dumas. The barium salt, dried at 100° *in vacuo* over phosphoric anhydride (no further loss at 120°), contains (Weiler and Strauss): C, 44·3; H, 4·85; N, 4·13 (Dumas), 4·2 (independent micro-Kjeldahl); C-Me, 11·6; Ba, 22·0 per cent (independent estimation 21·3). There was no phosphorus or sulphur, and no O-Me or N-Me groups. These results are in fair agreement with the formula $C_{24}H_{32}O_{10}N_2Ba$. This is provisional, and C_{23} and C_{25} formulæ are not excluded. The barium salt is strongly lævorotatory in aqueous solution. The absorption spectrum does not suggest that aromatic rings are present in the molecule. Hydrolysis affords one carbon dioxide molecule and other products, including a water-soluble volatile acid, and a substance giving a sparingly soluble picrolonate, flavianate and aurichloride.

While it is possible that the above observations hold for pure penicillin, we cannot definitely claim homogeneity of the material in the absence of the usual criteria of purity.

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W. BAKER.
E. CHAIN.
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R. ROBINSON.

University of Oxford,
March 18.

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[1] NATURE, 149, 328 (1942) and paper in the press.

Bactericidal Effects of *Aspergillus clavatus*

IN preparing enzyme concentrates from certain moulds, antibacterial activity was noted in material from a number of species characterized by high proteolytic capacity. Thus two strains of *Aspergillus clavatus* were found to be capable of sterilizing liquid media which had been infected with *Staphylococcus aureus* and other organisms. These moulds invest simple liquid media such as Csapek Dox solution with distinct antibacterial properties. Small portions of the medium on which the mould has been grown inhibit the growth of *Staphylococcus aureus* in glucose broth and other media. Larger quantities of medium are bactericidal, no viable organisms being demonstrable after the mixture of broth and medium has been incubated for several hours. In intermediate dilutions an initial phase of bacteriostasis may be followed by bactericidal action. The active substance differs from penicillin not only by being bactericidal as well as bacteriostatic, but also in several other respects. First it is relatively stable; filtrates may be handled without sterile precautions, and even high acidity is well tolerated. Aqueous solutions may be boiled without being inactivated. Furthermore, the substance inhibits the growth of, and in higher concentrates kills, a number of organisms that are not attacked by penicillin.

Concentrates of the active substance are obtained by absorbing it on charcoal directly from the liquid medium after removal of the mycelium, and by afterwards eluting the dried charcoal with ether. The ether-soluble fraction shows bactericidal potency in dilutions of 10^{-5}. Occasionally more potent fractions were obtained.

Antibacterial activity is also demonstrable in presence of serum, pus and urine. The medium and active concentrates thereof were administered without adverse effect to mice, to healthy human subjects and to a number of clinical cases. The protective effect *in vivo* remains to be studied in greater detail, but it appears that the active fraction inhibits strains of organisms which proved resistant to such agents as sulphonamides or mandelic acid.

My thanks are due to Prof. H. Raistrick, Mr. George Smith and Dr. Harry Coke for much help and advice.

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March 17.

Potable Water from Sea-Water

I WAS surprised that in his article on "Potable Water from Sea-Water" Dr. A. Parker[1] makes no reference to what seems to a biologist an obvious method—that found in the Bowman's capsule of the kidney. If a pressure greater than the osmotic pressure is applied to a solution bounded by a semi-permeable membrane, pure solvent will go through the membrane. The osmotic pressure of sea-water is about 450 lb./sq. in., a pressure reached over an area of 1 sq. in. by quite small car jacks with no more effort than can be applied with one finger. The only difficulty should be the semi-permeable membrane, and I suggest that research might profitably be devoted to producing a suitable one. It would not need to be perfect; if it let through 15 per cent of the salts, a two-stage pump would produce a liquid within the limit suggested by Dr. Parker for potability.

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[1] NATURE, **149**, 184 (1942).

IT was not possible in my relatively short article to mention all the methods, which have been suggested, for obtaining drinking water from sea-water. The intention was only to indicate the main principles of the methods.

Suggestions of the kind mentioned by Mr. Yapp have been considered. If a method involving the use of a semi-permeable membrane as a filter under pressure is to be suitable for use under conditions similar to those in open boats, it must meet the following requirements: It must be simple to operate. The membrane must be so robust or so supported that there is little or no risk of the membrane being broken or perforated during transport and use. The rate of passage of the drinking water through the membrane must be reasonably high, say about one pint an hour. It is also desirable in the particular circumstances that the treated water should not contain more than about 100 parts of salt in 100,000 parts; this means the removal of at least 97 per cent of the salt in sea-water.

Ultra-fine membranes of the collodion type under pressures of the order of 250 lb. per square inch have been used in experiments for the Water Pollution Research Board for the removal of bacteria from liquids and for the separation of finely dispersed colloids from saline solution. Experience has shown that although the rate of filtration is very slow, salts such as sodium chloride readily pass through these membranes. It may be that intensive investigation would lead to the discovery of a membrane satisfying the requirements, but the problem presents so many difficulties that the prospects of solving it within a short time are not great.

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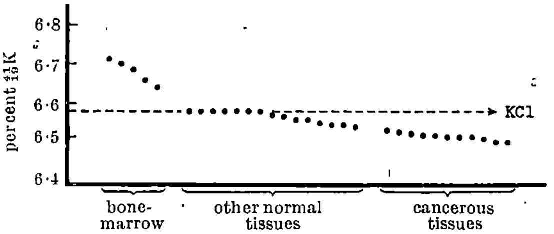
An Isotopic Shift of Potassium in Human Bone-marrow and Cancer

IN previous investigations it has been found that the isotopic constitution of potassium contained in bone-marrow and tumour tissue from the rat was appreciably different from that of potassium in various other normal rat tissues, the shift observed with 'bone-marrow potassium' being opposite to that observed with 'tumour potassium'. As regards potassium in normal tissues other than bone-marrow, the content of the heavy isotope, $^{41}_{19}$K, usually proved to be very close to that of mineral potassium as contained in ordinary potassium chloride (A.R.); only in a few exceptional cases was the $^{41}_{19}$K content slightly decreased[1,3]. However, with potassium in bone-marrow (that is, bone including marrow), a marked and regular increase in the content of $^{41}_{19}$K was obtained; on an average, the increase was 1·9 per cent[1,3]. This result agreed with earlier findings on potassium in bone-marrow from horse and beef[4]. A similar shift was further obtained with potassium present in rat blood plasma[2,3]. On the other hand, potassium in Jensen rat sarcoma showed a distinct decrease of its $^{41}_{19}$K content, and a similar result was found with potassium in mouse sarcoma 37*S*. The average decrease for both tumours was 1·1 per cent[1,5].

It was of interest to carry out similar investigations on potassium contained in human tissues. This has been done, so far, with postmortem material, taken as a rule twenty-four hours after death. A number of normal tissues ('non-cancerous' tissues in a stricter sense) were tested; they included five samples of bone-marrow, taken from lumbar vertebræ, and fifteen samples from liver, kidney, lung, spleen, brain, heart and skeletal muscle. All the samples were derived from organs which showed, on macroscopical examination, little or no pathological changes. Further tests were made with various kinds of cancerous tissue, consisting of eight samples of primary carcinomas which originated from liver, kidney, lung, stomach, colon and rectum, and of three samples of secondary carcinomas (metastases) of the liver. The preparation of ashes and the technique of mass-spectrographic analysis were similar to those previously described[3,6].



CONTENT OF $^{41}_{19}$K IN POTASSIUM PRESENT IN CERTAIN TISSUES FROM HUMANS.

Dotted line indicates content of $^{41}_{19}$K in mineral potassium as contained in potassium chloride, A.R.

The results are illustrated in the accompanying figure. Each recorded point indicates the percentage of $^{41}_{19}$K in potassium contained in one ash sample; the whole of the values is arranged in a descending order of magnitude, independently of the tissues concerned. It will be seen that there are five values which are above the level represented by the $^{41}_{19}$K content of mineral potassium; the increase is, on an average, 1·5 per cent. These values were obtained with bone-marrow. Another group of fifteen values corresponds to the other normal tissues mentioned, seven values being identical with the $^{41}_{19}$K content of mineral potassium and two fairly close to it. The six remaining values are slightly below this level. A more marked decrease, however, was obtained with cancerous tissues: all the eleven values were lower than any of those found with normal tissues. (The two highest values correspond to samples from secondary liver carcinoma.) On an average, the content of $^{41}_{19}$K was by about 1·0 per cent smaller than that of mineral potassium.

It can be said that the results are in general agreement to those obtained with corresponding tissues of animal origin. As in that case, the $^{41}_{19}$K content of potassium in bone-marrow is higher than that of mineral potassium and potassium in other normal tissues, while potassium in cancerous tissues shows regularly a lower content of $^{41}_{19}$K than that of potassium in every tested normal tissue. In particular, there appears to be some lack of agreement, especially if one considers that six of the values found with normal tissues have shown a certain approach to those obtained with cancerous tissues. In accounting for these values one has to remember that potassium in normal rat tissues showed occasionally a similar deviation, and it is further necessary to consider the possible influence of post-mortem changes and of pathological conditions in the tissue other than cancer formation. It is of interest to note, in this connexion, that three of the six tissue samples concerned originated from cancer cases, while the nine other tissue samples belonging to this group were obtained from non-cancer cases only. This might indicate that potassium in non-cancerous tissues of cancer-bearers approaches in its isotopic constitution that in the cancerous tissue: a conclusion which is consistent with previous findings on potassium in muscle tissue from tumour-bearing rats and mice[5].

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March 9.

[1] Lasnitzki, A., and Brewer, A. K., NATURE, 142, 538 (1938).

[2] Lasnitzki, A., and Brewer, A. K., NATURE, 146, 807 (1940).

[3] Lasnitzki, A., and Brewer, A. K., *Biochem. J.*, 35, 144 (1941).

[4] Brewer, A. K., *J. Amer. Chem. Soc.*, 59, 869 (1937).

[5] Lasnitzki, A., and Brewer, A. K., *Cancer Res.*, 1, 776 (1941).

[6] Brewer, A. K., *J. Indust. Eng. Chem.*, 30, 893 (1938).

Sheep Strike by the Fly, *Phormia terrae-novae* R.-D., in North-east Scotland

DURING May–July, 1941, my colleague, Mr. W. Moore, who is studying pesticides in the North of Scotland College of Agriculture, Aberdeen, accidentally found the fly, *Phormia terræ-novæ* R.-D., attacking sheep in north-east Scotland. In the last week of May, when fly-strike had become fairly general, Mr. Moore decided to clean out and disinfect the breeding-chamber for flies and to restock it with a fresh supply of the sheep maggot fly, *Lucilia sericata* Meigen, bred from maggots found on sheep. The first eleven batches of maggots were obtained from sheep on widely scattered farms. Each batch of maggots was reared under fly-proof conditions. The flies that emerged from the eleven batches of maggots were *Phormia terræ-novæ* R.-D. The species seemed the cause of primary strike in many cases. This is the first record of it striking sheep in north-east Scotland. Not until the second week of July did Mr. Moore obtain maggots of *Lucilia sericata* from sheep, and then he found it mixed with *P. terræ-novæ* in two cases. Later strike by *L. sericata* seemed to become general.

Since strike was very common during 1941 in the north-east of Scotland and since the species responsible for it was not investigated in most cases, it seems probable that *P. terræ-novæ* occurred commonly in strike, at least early in the year. Macleod[1], Haddow and Thomson[2], and Macleod[3] have recorded this fly striking sheep on the mainland of Argyll and in Mull, and in some instances the strike was apparently primary.

Very little is known about the habits and life-history of the insect in Great Britain; for example, the food of the majority of its larvæ is unknown. The insect is abundant in north-east Scotland. Some adults apparently hibernate, for I caught a female in April 1929, a male on March 30, 1930, and a female on April 9, 1930, in the loft of a house in Aberdeen. The flies seem to reach their maximum numbers towards the end of July and to disappear from the open during September–October. Between July 18 and October 10, 1933, I caught in a single trap in my garden in the suburbs of Aberdeen 799 females and 559 males (compared with 863 females, 96 males *Lucilia sericata*), and between June 13 and July 27, 1934, in five traps on a farm of the Rowett Research Institute, Aberdeen, 1,915 females, 1,078 males (compared with 2,249 females, 265 males *L. sericata*).

The traps were baited with carrion, which is highly attractive to the flies, though they rarely breed upon it according to my observations of insects bred from carrion. The only time I bred the insects on carrion—and this is somewhat doubtful, for the flies may have struck the sheep when it was still alive—was at Dornie, Ross-shire, where I found a number of puparia among the wool of a sheep that had died some weeks previously. The puparia were found on May 22, 1940, and flies emerged from them during June 2–10, 1940. Smirnov[4] found *P. terræ-novæ* the chief species of fly visiting baits of meat exposed in the open air in the U.S.S.R.; it seldom oviposited on them; its larvæ occurred chiefly in kitchen refuse.

Evans[5] found it the most resistant of four species of blowflies to high temperature and various humidities. In my trapping experiments I found the fly the most resistant of about thirty species of flies to the effects of chloroform.

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March 11.

[1] Macleod, J., NATURE, 138, 467 (1936).

[2] Haddow, A. J., and Thomson, R. C. M., *Parasitol.*, 29, 96 (1937).

[3] Macleod, J., *Proc. Roy. Ent. Soc. Lond.*, A, 12, 127 (1937).

[4] Smirnov, E. S., *Med. Parasitol.*, 6, 872 (1937); *Rev. Appl. Ent.*, B, 26, 204 abstract.

[5] Evans, A. C., *Parasitol.*, 28, 431 (1936).

RESEARCH ITEMS

Floral Morphology and Angiosperm Phylogeny

THE *Transactions and Proceedings of the Botanical Society of Edinburgh* (33, Pt. 2; 1941) contains the presidential address by J. R. Matthews upon floral morphology and its bearing upon the classification of Angiosperms. His review makes it abundantly clear how every concept associated with the classical view that floral organs are necessarily modified leaves has been challenged at one time or another. The recognition of stamen and carpel as sporophyll forms, which led to the attempt of Arber and Parkin to reconstruct a hypothetical pro-angiospermic type allied to the Bennettitales, called forth Chamberlain's emphatic statement that any such origin of the Angiosperm must be regarded not merely as improbable but as impossible. Hooker is quoted from a letter to Newell Arber, dated 1907, as holding to Robert Brown's view of the Angiosperm orders "being reticulately, not lineally, related" and there is an interesting discussion of the phylogenetic value of the polyadelphous character of the stamen. Thus the typical stamen may be regarded as the result of a progressive shortening of a dichotomizing branch system while Hunt (1937), as a result particularly of a study of stigma and style, has similarly concluded that the carpel may be traced ultimately to a dichotomous branch system. There is no discussion of Grégoire's rejection of homologies between reproductive and foliar organs, but McLean Thompson's decision that the inferior ovary is 'acarpous' is presented. Grounds are given for the conclusion that "there is clear evidence also of a re-awakening of interest in the problems of taxonomy and phylogeny".

Chemistry of Pterins

AT a meeting of the Royal Society on March 19 Sir Frederick Gowland Hopkins described some experiments chiefly concerned with a derivative from pterins. These pigments have become prominent of recent years, partly on account of the prolonged efforts (1925–1941) of Continental workers to determine their nature. The progress of these constitutional studies has quite recently become dramatic. Moreover, one pterin at least has been shown to occur in mammalian tissues, with probable physiological functions there. The derivative examined involves an oxidation by molecular oxygen in solution of low pH. On the acid side of neutrality its formation proceeds throughout a wide range of pH values, but not at all on the alkaline side. From one pterin (erythropterin) the yield is large. From another (xanthopterin) it arises only in special circumstances, which are of considerable interest. The properties and behaviour of this derivative (which in some respects are exceptional) are described. No evidence bearing on the actual constitution of the product has yet been obtained. It seems justifiable to claim, however, that until the structure of this derivative is determined and the mechanism of its formation made clear, the chemistry of the pterins will remain incomplete. Another section of this paper deals briefly with the yellow products which occur when aqueous suspensions of uric acid are heated in sealed tubes at high temperature. These show properties strikingly akin to those of the pterins, and in particular yield purple derivatives in precisely those circumstances which lead to the formation from the natural pigments of the products dealt with in this paper which they closely resemble.

Submarine Contours of the North Pacific

SONIC sounding has increased our knowledge of the details of bathmetrical relief. F. Betz and H. Hess have produced in the *Geographical Review* of January a map of submarine contours of the North Pacific ocean based on the United States Hydrographic Office chart of that ocean in 1939. The detail now available allows the authors to discuss anew the probable structure of the ocean floor. The most interesting suggestions relate to the large number of trend lines in the relief. An orientation N. 75°–80° is particularly notable, but others cross these trend lines, and in particular the Hawaiian rise or swell, the main axis of which is N. 55°–75° W. The shape and other characters of the Hawaiian swell suggest that it is not, as often supposed, a folded ridge, but a fissure or perhaps tension crack accompanied by the extrusion of large amounts of volcanic material. Probably the extrusion covered a long period of geological time. The down bending of the crust beneath the load would account for the slight longitudinal depressions along the margins of the swell. The authors further suggest that the fissure, as, indeed, other Pacific fissures, opened along the strike, so that the origin of these structures is in transcurrent folds which would also explain the relative straightness of these trend lines. Other transcurrent faults in continental structure are cited, and their configurations shown to agree with the Hawaiian and Pacific rises generally. All are not associated with volcanic outpourings.

Magnetostriction in Permalloy

Messrs. Williams, Bozorth and Christensen, of the Bell Telephone Laboratories staff, have found (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941) that magnetostriction in 68 per cent nickel permalloy varies by a factor of ten when the metal is subjected to heat treatment while being oriented in different directions in a magnetic field. Magnetization was also found to affect the elasticity and rate of damping of mechanical vibrations of this material. The tests were conducted on a hollow rectangular specimen wound with long thin coils to form a closed magnetic circuit, thus avoiding demagnetizing effects. The minute changes in dimensions, corresponding to a few millionths of a centimetre for each centimetre length of the specimen, were measured by reflecting light from a small mirror, which was rotated slightly by the expansion or contraction of the material caused by magnetostriction.

Torque on a Silicon Iron Crystal in a Magnetic Field

A DISK cut from a single magnetic crystal generally tends to rotate into a preferred position when placed in a magnetic field. This tendency usually increases with field strength up to saturation, but for some directions of magnetization it has recently been found to pass through a maximum, decreasing with further increase of field strength. R. M. Bozorth and H. J. Williams (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941) have recently shown that this behaviour can be explained by the domain theory of magnetism, which describes a magnetic material as consisting of groups of atoms acting as units. When placed in a magnetic field, these units tend to turn into the direction of the field, the specimen tending to rotate as a whole. Calculations show that for some directions of magnetization, this tendency passes through a maximum as the domains change their alinement under an increasing field. The calculations are confirmed by the authors' experiments, in which the tendency of the crystal to rotate is determined by supporting it on a wire between the poles of an electromagnet and measuring the twist of the wire necessary to counteract the torque.

Impulse Electric Strength of High-voltage Cables

AN official communication (Ref. L/T126) from the British Electrical and Allied Industries Research Association is presented by R. Davis, of the National Physical Laboratory, in the February issue of the *Journal of the Institution of Electrical Engineers* (89, Pt. II, No. 7), giving the results of tests made mostly on virgin paper-insulated single-conductor cables of the solid or mass-impregnated type, but in addition on varnished-cambric, non-bleeding paper, H-type multicore, and belted-type cables. The conclusions reached refer only to the cables tested. The minimum impulse electric strength of virgin mass-impregnated paper-insulated single-conductor and multicore screened cable is approximately constant at 1,000 kv./cm., being independent of the voltage rating and of the sectional shape of the conductor, whether circular or elliptical. The effect of the wave shape of the applied surge on the puncture voltage and of repeated applications of surge voltage less than that necessary to cause puncture, is small. In general the positive puncture value is a few per cent higher than the negative. With impulse-voltage stressing, the non-bleeding and varnished-cambric types of cable punctured at a lower voltage than the fully impregnated types. While no direct comparison has been made between aged and unaged cables which are otherwise identical, the tests have failed to differentiate between the behaviour of aged and virgin cable with impulse voltages. The research continues.

The Electric Spark

AN important contribution to the study of the electric spark is contained in a paper read recently by J. M. Meek before the Institution of Electrical Engineers in which the author first discusses the inadequacy of the classical theory of spark discharge when applied to long gaps at atmospheric pressure. A brief description of the streamer theory of the spark follows, which latter not only explains the observed sparking phenomena but also incorporates a criterion, based on atom-physical considerations, facilitating the calculation of the breakdown potentials of different gaps in which the field distribution is known. For gaps in which corona is observed to precede sparkover, the corona onset voltage is that determined. The results of such calculations for various types of gaps are described, with particular reference to the sphere-sphere gap. Various features of point-plane breakdown are also mentioned, and an explanation is given for the occurrence of the upward-growing positive streamer from the earthed plane when the high-voltage point is of negative polarity. It is further shown that in the case of lightning discharge from a negative cloud to earth in open country, upward-growing positive streamers from the earth are not likely to be more than a few metres long and thus will rarely be observed. Irradiation and statistical time-lag are dealt with in some detail. Various experiments are described, and it is shown that quite different results can be obtained according to whether the gap is illuminated or not by the light from neighbouring spark-gaps. The effect of such irradiation is found to be important for short gaps and for gaps several cm. long, and in particular for the positive impulse breakdown of a sphere-gap when the spacing is greater than that corresponding to the Toepler discontinuity. The lowering of spark-over voltage for uniform and non-uniform gaps by the intense light radiated from a nearby spark source was also investigated and an explanation of the various results obtained is given in terms of the new theory of the spark.

Concrete at Low Temperatures

THE problem of concreting in freezing weather frequently arises. It is well known that the structural value of concrete if 'frozen' may be utterly destroyed, and consequently present-day methods prescribe that if concrete is placed in freezing weather it will be heated and maintained by insulating material at temperatures well above freezing point. The additional use of calcium chloride has been suggested, as it speeds the attainment of strength and reduces the time during which protection is necessary. As a small quantity of calcium chloride reduces the freezing point of water by only a few degrees, it has been assumed that calcium chloride would not prevent the freezing and destruction of concrete cooled well below freezing point. J. C. Yates, of the Calcium Chloride Association, working at the U.S. National Bureau of Standards, has made specimens of concrete at 70° F. containing 0, 2, 3 and 4 per cent of calcium chloride by weight of cement, immediately placing them in rooms kept at various temperatures maintained between 20° F. and 40° F. (*J. Frank. Inst.*, Jan., 1942). The specimens were removed one day before testing, and it was found that with the exception of the plain concrete all had gained strength. At 28 days, the plain concrete at 25° F. had a strength of 1,130 lb./in.^{2}, at 32° F. a strength of 3,150 lb./in.^{2} and at 40° F. a strength of 3,790 lb./in^2. The addition of calcium chloride increased the strength at all temperatures and ages. The earlier the age and lower the temperature the greater the effect. With 4 per cent calcium chloride, the 28-day strength at 20° F. was 1,370 lb./in.^{2}; at 25° F. the strength increased from 1,130 to 3,030 lb./in.^{2}.

Galactic Absorption and Apparent Distribution of Spectral Types

GEORGE ALTER has shown that the absorption conditions in a uniform and continuous absorbing galactic layer can be determined by the observed relation between colour index and absolute magnitude, and limits are given for the absorption coefficients (*Mon. Not. Roy. Astro. Soc.*, 101, 2, 84). The influence of this absorbing layer was shown to be dependent on a parameter *b*, the qualities of which are discussed in a recent paper on the subject (*Mon. Not. Roy. Astro. Soc.*, 101, 8). The investigation is extended to absorbing layers which are either discontinuous or non-uniform, or both, and thus includes irregular absorbing clouds. Various conditions of interfering absorbing matter are assumed, and an attempt is made to derive the relation between true star distances and those determined by observed colour indexes. Alter shows that this interfering matter is responsible for falsifying the average mixture of spectral types, and in some cases the mixture falsification under certain assumptions becomes very complicated. Deductions of the investigation are confirmed by an instance from a colour index examination in a region of absorbing clouds.

COFFEE GROUNDS IN ANIMAL RATIONS

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DURING war-time the urgent need for more foodstuffs for human consumption results in oats and other feeding stuffs commonly used for animals being largely diverted from animal rations, for which therefore other materials must be found. Among the substitutes for concentrates in the rations of the domestic group of animals (for example, pigs, poultry and rabbits), household food scraps have to make a large replacement. For this purpose house-waste is collected individually, or in some urban areas by the local authority. The majority of the food-scraps are of approximately known feeding-stuff value, but the values of some ingredients that may be present, such as coffee grounds, are more problematical. Coffee grounds are not generally used as a feeding stuff, but during the War of 1914–18 coffee grounds were collected and fed to livestock in many parts of Germany[1], although the digestibility of their crude protein was very low, namely, 11–20 per cent.

The general chemical character of spent coffee grounds is illustrated by two samples of dried coffee dregs from the second infusion which gave the following composition[2], per cent: water, 9·45 and 11·42; fat, 11·64, 12·45; nitrogen, 11·68, 11·5; caffeine, traces; starch, 17·00, 22·47; sugar, traces; ash, 1·71, 2·03; nitrogen-free extras, 14·81; and fibre, 25·30 (second samples).

Coffee dregs have been fed to cattle (beef and dairy), horses, pigs, rabbits and poultry (chickens and ducks). They were found to be more suitable when powdered and fed very dry, instead of as grains. The following amounts could be consumed daily: steers 3·3 lb., cows 2·2, horses 1·7, but preferably only up to 0·8 lb.[2] From other experiments it transpired that not all animals would eat the finely ground coffee dregs[3]. When horses received 1·1 lb. daily, in place of a similar quantity of oats, it produced nervous excitement. Apart from these scanty reports there is little guidance as to the feeding value, if any, of coffee dregs as an animal foodstuff in war-time rations.

Although Great Britain is primarily a tea-drinking country, during 1935–37 the apparent annual consumption of coffee rose from 294 thousand hundredweights to 302 thousand hundredweights and may have increased further since the introduction of tea rationing. The weight of refuse grounds available must be very considerable, and the frequency with which they will be mixed with the general household food waste makes it desirable that further information as to their value should be obtained. (To cope with the high production of coffee, Brazil destroyed 30 per cent of the pre-war crop. In the period June 1931–August 1938 more than 74,000,000 hundredweight were thus destroyed. Stocks remained high and coffee planting was forbidden. United Kingdom imports were then almost entirely confined to high-grade coffee from East Africa, India and Costa Rica.)

In 1939 observations were made in the Rabbit Section of the National Institute of Poultry Husbandry on feeding small quantities of coffee dregs in the maintenance rations of different types of rabbits. For the first two or three days this material was generally left uneaten, but by reducing the concentrates most of the animals were soon induced to eat the fresh coffee dregs, up to the equivalent of 10 per cent of the concentrates, although a few individual animals remained adamant in their refusal. Afterwards the following small experiment was initiated to continue through the period of winter food scarcity, prior to the growth of appreciable quantities of spring greenfoods.

Twenty adult rabbits were divided into two equal groups, of similar live weight, housed in individual hutches and fed on mixed rations consisting of approximately 8·3 oz. roots, 1·7 oz. hay, and 2·3 oz. mash to the control group, while the other group had 10 per cent (on dry matter basis) of the concentrates replaced by fresh spent coffee grounds. Four times the weight of fresh moist grounds were fed to replace one of dry food. The daily quantities were modified slightly to a level where the coffee group cleared their daily ration, and roots were fed more extensively. The roots and hay were fed in equal quantities to both control and coffee-fed groups. The details of food consumption are set out in Table 1, by periods of lunar months.

TABLE 1.—AVERAGE DAILY FOOD CONSUMPTION (OUNCES).

	Control			Coffee			
Period	Mash dry	Roots, etc	Hay	Mash, dry	Coffee	Roots, etc.	Hay
1	2·32	8·29	1·71	2·09	0·93	8·29	1·71
2	2·14	11·20	1·77	1·93	0·86	11·20	1·77
3	2·05	11·20	1·71	1·85	0·82	11·20	1·71
4	2·05	11·20	1·71	1·85	0·82	11·20	1·71
Average	2·14	10·48	1·73	1·93	0·86	10·48	1·73

There was a noticeable tendency for the coffee grounds to be left until the other foods had been eaten, thus indicating that they were less palatable, although better than nothing, and were consumed in moderation up to 0·8–0·9 oz. On both of these rations the general condition and live weight were maintained, although there was a slight temporary drop, but this was due to seasonal modifications in the feeding of roots during frosty weather, and affected both groups. Apart from this their condition was maintained and later showed the usual small gains in live weight, in both the control and the coffee-fed animals, as seen in Table 2.

TABLE 2.—AVERAGE LIVE WEIGHTS.

	Control	Coffee	Difference
	lb. oz.	lb. oz.	oz.
Initial L. Wt.	8 6·50	8 6·30	−0·20
1 Month	8 2·90	8 4·60	+1·70
2 ,,	8 1·20	8 1·20	—
3 ,,	8 8·70	8 4·50	−4·20
4 ,,	8 11·20	8 9·40	∓1·80
Average Gain	4·70	3·10	−1·60

Apart from improvement in live weight and body condition, there were regular observations of the fur development. There was a slight tendency to lose the coat gloss in the first period on coffee, which was followed by heavy shedding of the fur of four of the coffee-fed animals. Otherwise the general condition of the fur of both groups was generally good during the feeding of both rations. The only other noteworthy observation was that three animals appeared to move with a somewhat shaking gait from eight to ten weeks after the commencement of the coffee feeding. When inspected by the veterinary officer he asked for close observations to be kept on them. However, this tendency decreased and was not noticeable after twelve weeks, when they moved about more or less normally.

During the last period the stock in both groups was mated and the coffee-feeding was terminated. The fertility of the two groups showed little difference in the proportion of fertile does from this batch of matings. In the control group eight produced litters and in the coffee ration seven, a difference of only one.

The diet had a direct effect upon thirst, and whereas the controls, receiving dry mash, drank 5·2 oz. of water daily, those receiving a 10 per cent replacement of fresh (moist) coffee dregs only drank 3·1 oz.

[1] Bruttini, A., "Uses of Waste Materials" (1923).

[2] Aruch, E., *L'Italia Agricola*, 55, 299 (1918).

[3] Bretana, *La Riforma Agraria*, 1, 264 (1920).

AIR-RAID DAMAGE AND ELECTRICITY SUPPLY

A FURTHER series of articles in the February issues of the *Electrical Review* record instances of the air-raid damage sustained by overhead lines, cables, and substation equipment, and the steps taken to effect repairs and restore supply (see also NATURE of February 7, p. 173). Although many engineers fully expected that overhead lines in the path of bomb blast would be levelled to the ground, actual damage has not reached a quarter of that anticipated. Admittedly, line conductors have suffered, and on pin type insulator lines, conductor binders have been severely strained, but it requires direct hits on towers or poles to interfere seriously with supplies. Bomb splinters, not blast, are generally responsible for the damage, stranded conductors showing definite evidence of having been severed. Wood poles appear to withstand blast better than steel ones, one large rural undertaking reporting that out of many near misses, only one wood pole was rendered unserviceable. Damage to pole transformers is rare and is usually only a slight puncturing of the casing.

As an indication of the amount of damage substation equipment can withstand, a switchboard which was blown right out by blast needed only minor wiring repairs. On another occasion a large outdoor transformer had its cooling tubes pierced at their lowest point by bomb splinters, and although the entire oil contents drained away the plant continued to function. At a certain static substation, a large bomb almost dived under the floor, which was split into four complete sections. Each of these, containing plant, was raised a foot and was at a different angle from its neighbour. The 6·6-kv. switchgear was found at an angle of 15° to the normal horizontal plane, many insulators were cracked and broken, all the trifurcating cable-box supporting lugs were torn away, and feeders were left hanging by their tails. The transformers were moved 2 ft. and lay taut on their cables, while the low-voltage floor-mounted switch-fuse gear was flat on its back with all the cable plumbing cracked. The roof was distributed among the plant, but the supply was maintained. A heavy bomb fell close to the side wall of another substation containing a 500-kw., 6·6-kv. to 460-v. D.C. glass bulb rectifier equipment. The substation was rendered nearly roofless and quite windowless and doorless, but the electricity supply remained intact. When the internal debris was cleared away it was found that the entire substation equipment had been moved at least 6 in. One rectifier bulb was destroyed but it had successfully cleared its A.C. and D.C. protection; the remaining three bulbs were unharmed and complete automatic control remained.

A safeguard employed by one undertaking against incendiary bombs on slate-roofed buildings is the placing of iron sheeting above the 2 in. of sand which is recommended for covering the rafters or flooring immediately below the roof. This sheeting absorbs the impact of the bombs, which otherwise has a tendency to disturb the sand. Substations appear to suffer little damage from fire, and it is not uncommon to find that they are the only part surviving of buildings destroyed by this means.

Ideas are being rapidly revised on the subject of fire danger to transformers. Instances are recorded of their having been charred, their insulation burnt off underneath, their oil having been boiling and actually burning, and their connecting cables being burnt off to stumps at the point of entry, but in each of these cases the apparatus has been salvageable.

Damage to cables has provided the largest source of instructive facts and problems. Although, despite the most severe bending, stretching, twisting and flattening, cables frequently remain in service, it cannot be taken for granted that an apparently sound length is unharmed. In many cases steel armouring has been found to have saved cables from damage, but it is advisable to carry out a pressure-test from at least the draw boxes on either side of the crater. Sometimes damage is caused to cable joints by vibration from nearby bombs, resulting in water entry. Pilot cables are often damaged although the main cables remain unharmed. Remarkable instances are reported of cables remaining alive after almost unbelievable damage. A 6·6-kv. cable cut by a bomb splinter remained in service for a fortnight, lying under debris without breaking down.

An indication of the depth of penetration that may be expected with some types of high-explosive bombs is provided by a chance hit on a 33-kv., 0·18-sq. in. submarine cable passing across a river mouth. This was damaged although the cable was some feet below the river bed and the water was several feet deep.

Restoration of electricity supplies after an air raid is very much simplified by having the area split up into sections, which, in a large area, may be self-contained and each have its own emergency repair gang. In repairing mains ruthless amputation of faulty sections is generally found to be the most successful course to adopt. Normally, cable saving has always been of paramount importance with distribution engineers, but under 'bomb conditions' experience has shown the necessity for quickly 'cutting and sealing' at the most convenient place for, generally, the craters quickly fill with water from damaged mains. Comparatively seldom, however, does the urgency of restoring supplies justify temporary cable repairs. While special emergency joints utilizing cold-filling compound have apparently justified their makers' claims, the general consensus of opinion is that they are not often warranted on the score of saving a few extra hours and should be used only when immediate recommissioning of the cable is essential. It must be emphasized that while some manufacturers claim their cold-filling joints are permanent, these joints are primarily for emergency use, and permanent repairs usually have to be carried out later. Failure to appreciate the necessity for very efficient mixing was, in fact, the cause of the breakdown of an 11-kv. joint after three months' operation. Another undertaking has come to the conclusion that the use of these joints is advantageous for cables of 33-kv. and higher, considering the saving of approximately a day and a half in the repair work worth while. In the bridging of cables across craters, many devices have been widely adopted, such as the use of scaffold poles as supports and the suspension of the cables temporarily on adjacent walls. Another scheme is the utilization of steel structures to support the cables temporarily while other parties requiring access to the crater attend to their work. These steel structures, which are generally covered with boarding to give the cable protection against stray splinters of anti-aircraft shells, etc., are erected rapidly and leave an almost clear space around for other work to be undertaken.

Practically all undertakings have now come to the conclusion that there is nothing to be gained by attempting anything in the way of actual repairs, apart from isolating bad sections of the system and restoring supplies to sound sections by means of alternative switching, while the raid is still in progress, except in very special circumstances. Apart from the unwarranted risk to personnel, little can be done until daylight. Much time and money is spent unnecessarily on having emergency repair gangs on duty throughout the twenty-four hours, and without any question of slackness it has been proved in practice that a much more satisfactory arrangement is to have the men standing by in their own homes and to call them up by telephone, or even by messenger, only when actually needed.

MARINE RESEARCH IN THE UNITED STATES

THE eight papers in the latest number of the *Journal of Marine Research** deal with all aspects of oceanography, physical, chemical, biological and bacteriological.

A. H. Woodcock continues an earlier inquiry into the effect of cold winds on a water surface. In shallow water the cooled surface water finds its way downwards by converging into small-scale streamings about 1 cm. across and several centimetres apart running parallel downwind. In vertical section a shallow surface stratum is broken up into a series of convection cells, and at the surface there are alternate convergent and divergent strips. In the open sea the small-scale streaming is present on the surface of the large waves, but there is also a large-scale convection mechanism with streams 50–100 ft. apart. On the small scale, lycopodium powder dusted over the surface falls at once into the linear pattern, and the gathering of Sargassum weed into parallel strips under the influence of a cooling wind is used as evidence of large convection cells.

Whitney describes measurements of the scattering of daylight in sea water. Whatever the altitude of the sun the light becomes more and more vertical as it penetrates, until it appears to reach an equilibrium distribution in which the light received from below is about half that received horizontally and roughly a fortieth of that from above. The depth at which such equilibrium is reached seems to vary between 5 and 30 metres according to the turbidity of the water. The measurements were made off the United States Atlantic coast and in a freshwater lake.

The waters off the United States Pacific coast are described by R. B. Tibby, who has measured the proportions of subarctic and equatorial waters in a broad coastal belt.

The first of the chemical papers deals with the $Na^{\cdot}/Cl'$ ratio in sea water. The relative concentration of all important ions in the sea is remarkably constant, but Robinson and Knapman, using a direct analytical method, have found a slightly higher ratio of $Na^{\cdot}$ to Cl' in the coastal waters of Puget Sound than in the open Pacific Ocean. The method will be of great value in studying small variations or continuous trends in the composition of sea water.

Sanderman and Utterback, measuring the radium content of bottom sediments off the west coast of America from Canada to the Arctic Ocean, confirm the earlier conclusion that deep sea sediments are richer in radium than those of the land areas, and that the concentration is largely confined to a very thin surface film. Their richest sample was one that was just skimmed from the sea bed, so fine that it took several days to settle. While admitting that the plankton is 100–1,000 times as rich in radium as the surrounding water they agree with earlier workers that the role of plankton as a carrier of radium to the bottom is likely to be negligible; their sediments from the regions of most abundant plankton were no richer than those from the most barren areas.

The biological papers deal mainly with the phytoplankton. W. E. Allen discusses the mechanism by which diatoms suspend themselves at levels favourable for their growth, or in some way keep contact with them. He considers their production of oils and gases, methods by which they can exert more or less friction on the surrounding water, and the possible effects of turbulent water movements. He believes that there are no reliable data for estimating the rate of sinking, laboratory methods lacking dependability for estimating the rates under complex sea conditions.

Gordon A. Riley summarizes his work on the plankton of the western North Atlantic in a diagram which illustrates the relationships between the phytoplankton and its environment. He makes an attempt to give algebraic expressions for the relative importance of the different factors. The equations need testing, and are likely to apply better to average than particular conditions, but they give some hope that the phytoplankton production will eventually be predictable with some accuracy.

A bacteriological paper is by C. W. Hock, who has isolated bacteria capable of decomposing chitin, the tough leathery substance found in both rigid and flexible parts of most invertebrates. The bacteria which attack this very inactive substance have been found in sea water, marine sands and muds, and in the intestines of several marine animals. Two species are described, both aerobic; ammonia-reducing substances and organic acids were among the products of decomposition.

G. E. R. DEACON.

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* *Journal of Marine Research*, Vol. 4, No. 2, 1941. Sears Foundation for Marine Research, Bingham Oceanographic Laboratory, Yale University

FORTHCOMING EVENTS

Monday, March 30

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. C. E. N. Bromehead: "The Early History of Water-Supply".

Thursday, April 2

Town and Country Planning Association (in the Dome Lounge, Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—"Reconstruction and the Land".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Borough Electrical Engineer and Manager—The Town Clerk, Town Hall, St. Helen's, Lancs. (endorsed "Appointment of Electrical Engineer and Manager") (April 6).

Director of the Welsh Plant Breeding Station and Professor of Agricultural Botany—The Principal, University College of Wales, Aberystwyth (April 11).

Lecturer in Biochemistry—The Secretary, The University, Edmund Street, Birmingham 3 (April 25).

Engineer for the Sierra Leone Government Public Works Department—The Central Register (E. 370), Queen Anne's Chambers, Tothill Street, London, S.W.1.

Teacher of Physics in the Science Department—The Principal, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

Lecturer (man or woman) in Mathematics in the Junior Technical School for Boys—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

Professor of Anatomy—The Secretary, University College, Cork.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institute of Chemistry of Great Britain and Ireland. The Precious Metals. By H. Gordon Dale. (Twenty-fourth Streatfeild Memorial Lecture, 1941.) Pp. 20. (London: Institute of Chemistry.) [232

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 5, No. 1 (January–June 1941). Pp. ii+14. (London: Royal Meteorological Society.) 2*s.* 6*d.* [252

Transactions of the Royal Society of Edinburgh. Vol. 60, Part 2, No. 16: The Macrofauna of the Intertidal Sand of Kames Bay, Millport, Buteshire. By Dr. E. Emrys Watkin. Pp. 543–561. (Edinburgh and London: Oliver and Boyd.) 2*s.* 6*d.* [262

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 47: Phosphate Separation in Qualitative Analysis. By Prof. J. Reilly and M. O'Brien. Pp. 447–458. 1*s.* Vol. 22 (N.S.), No. 48: Note on the Analysis of an Irish Phosphate Ore. By C. L. Simpson and Prof. J. Reilly. Pp. 459–470. 1*s.* (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [262

British Empire Cancer Campaign. Eighteenth Annual Report of the Grand Council, 1941. Edited by J. P. Lockhart-Mummery. Pp. xii+238. (London: British Empire Cancer Campaign.) [272

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 13, No. 2, September 1941. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+79–155. (London: H.M. Stationery Office.) 4*s.* 6*d.* net. [23

Smoke Prevention in relation to Initial Post-War Reconstruction. Pp. 24. (Nottingham: National Smoke Abatement Society.) 2*d.* [23

No Clean City: the Need for Smoke Prevention in Post-War Reconstruction. Pp. 14. (Nottingham: National Smoke Abatement Society.) 2*d.* [23

Éire: Roinn Talmhaidheachta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Report on the Sea and Inland Fisheries for the Year 1940. (P. No. 5036.) Pp. 32. (Dublin: Stationery Office.) 6*d.* [93

Other Countries

Bulletins of Indian Industrial Research. No. 23: Dry Cell Manufacture. By G. D. Joglekar, Dr. K. Subba Ramaiah and Dr. Lal C. Verman. Pp. iv+58. (Delhi: Manager of Publications.) [232

Proceedings of the United States National Museum. Vol. 90, No. 3117: Notes on the Birds of North Carolina. By Alexander Wetmore. Pp. 483–530. Vol. 90, No. 3118: Notes on some North and Middle American Danaid Butterflies. By Austin H. Clark. Pp. 531–542+plates 71–74. Vol. 90, No. 3119: A New Genus of Psammocharid Wasp from China. By P. P. Babiy. Pp. 543–546. Vol. 90, No. 3120: Two New Species of Cecidomyiid Flies from Phlox. By Charles T. Greene. Pp. 547–552. Vol. 91, No. 3123: The North American Moths of the Genus Arachnis, with One New Species. By J. F. Gates Clarke. Pp. 59–70+plates 10–12. Vol. 91, No. 3124: Some Little-known Fossil Lizards from the Oligocene of Wyoming. By Charles W. Gilmore. Pp. 71–76. Vol. 91, No. 3125: New Species of Hydroids, mostly from the Atlantic Ocean, in the United States National Museum. By C. McLean Fraser. Pp. 77–90+plates 13–18. Vol. 91, No. 3126: The Nevada Early Ordovician (Pogonip) Sponge Fauna. By R. S. Bassler. Pp. 91–102+plates 19–24. Vol. 91, No. 3127: The Mexican Subspecies of the Snake *Coniophanes fissidens.* By Hobart M. Smith. Pp. 103–112. Vol. 91. No. 3128: Report on the Smithsonian-Firestone Expedition's Collection of Reptiles and Amphibians from Liberia. By Arthur Loveridge. Pp. 113–140. Vol. 91, No. 3129: Notes on some Crayfishes from Alabama Caves, with the Description of a New Species and a New Subspecies. By Rendell Rhoades. Pp. 141–148. Vol. 91, No. 3130: Notes on the Snake Genus Trimorphodon. By Hobart M. Smith. Pp. 149–168. (Washington, D.C.: Government Printing Office.) [242

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1941. (Publication 3643.) Pp. ix+136+5 plates. (Washington, D.C.: Government Printing Office.) [252

Smithsonian Miscellaneous Collections. Vol. 101, No. 7: Archeological Remains in Central Kansas and their Possible Bearing on the Location of Quivira. By Waldo R. Wedel. (Publication 3647.) Pp. ii+24+10 plates. (Washington, D.C.: Smithsonian Institution.) [252

U.S. Department of Agriculture. Miscellaneous Publication No. 466: Annotated List of Elm Insects in the United States. By Clarence H. Hoffmann. Pp. 20. 5 cents. Technical Bulletin No. 782: Field Studies of Insecticides used to control Cabbage Caterpillars in the South. By W. J. Reid, Jr., Chas. E. Smith, L. B. Reed and W. A. Thomas. Pp. 36. 10 cents. (Washington, D.C.: Government Printing Office.) [252

Brooklyn Botanic Garden Record. Vol. 31, No. 1: Trees in the Brooklyn Botanic Garden, 1942. By Alfred Gundersen and Arthur H. Graves. (Guide No. 13.) Pp. 54. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) 25 cents. [252

Proceedings of the American Academy of Arts and Sciences. Vol. 74, No. 9: The Approximate Solution of Singular Integral Equations arising in Engineering Practice. By Francis B. Hildebrand. Pp. 287–296. 85 cents. Vol. 74, No. 10: The Inner Chapters of Pao-P'u-Tzŭ. By Tenney L. Davis and Ch'ên Kuo-fu. Pp. 297–326. 1 dollar. Vol. 74, No. 11: An Experimental Study of the Absolute Temperature Scale. 6: The Gas Thermometer Assembly and the Experimental Method, by James A. Beattie, David D. Jacobus, John M. Gaines, Jr., Manson Benedict and B. Edwin Blaisdell; 7: The Theory of the Correction of the Observations on Gas Thermometers for the Imperfections of the Apparatus and of the Thermometric Fluid, by James A. Beattie, Manson Benedict and Joseph Kaye; 8: The Thermal Expansion and Compressibility of Vitreous Silica and the Thermal Dilation of Mercury, by James A. Beattie, B. Edwin Blaisdell, Joseph Kaye, Harold T. Gerry and Clarence A. Johnson; 9: The Determination of the Capillary Depression and Meniscus Volume of Mercury in a Manometer, by James A. Beattie, B. Edwin Blaisdell and Joseph Kaye. Pp. 327–398. 2 dollars. (Boston, Mass.: American Academy of Arts and Sciences.) [262

Report on the Administration of the Meteorological Department, Burma, 1937–41. Pp. iii+18. (Rangoon: Government Printing and Stationery Office.) 8 annas; 9*d.* [23

U.S. Department of Agriculture. Farmers' Bulletin No. 1890: Control of Insects and Mites attacking Narcissus Bulbs. By Charles F. Doucette. Pp. ii+25. (Washington, D.C.: Government Printing Office.) 10 cents. [23

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 9): Supervision of Secondary Education as a Function of State Departments of Education. By Carl A. Jessen and W. T. Spanton. Pp. vi+44. 10 cents. Leaflet No. 61: Federal Funds for Education, 1938–39 and 1939–40. Pp. v+30. 10 cents. (Washington, D.C.: Government Printing Office.) [23

Astrographic Catalogue 1900.0, Sydney Section, Dec. −51° to −65°, from Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 24: R.A. 18^{h} to 24^{h}, Dec. −56° to −58°, Plate Centres Dec. −57°. Pp. 40. (Sydney: Government Printer.) [23

Indian Eugenics Society. Bulletin No. 1: Aims and Objects of Eugenic Researches in Bengal. By S. S. Sarkar. Pp. iii+24. (Calcutta: Indian Eugenics Society.) 12 annas; 1*s.* [33

Canada: Department of Mines and Resources: Mines and Geology Branch, Geological Survey. Paper 41-10: Steveville Oil and Gas Field, Alberta (Summary Account). By J. S. Stewart. Pp. 16+map. 10 cents. Paper 41-12: Preliminary Map, Beaver Mines, Alberta. By C. O. Hage. 10 cents. Paper 41-13: Areas in the Vicinity of Steeprock Lake, Rainy River District, Ontario (Summary Account). By T. L. Tanton, Pp. iii+6+4 maps. 10 cents. (Ottawa: King's Printer.) [33

Canada: Department of Mines and Resources. Report of Mines and Geology Branch for the Fiscal Year ended March 31, 1941. Pp. 7–62. (Ottawa: King's Printer.) [33

Canada: Department of Mines and Resources: Mines and Geology Branch, Bureau of Geology and Topography: Geological Survey. Memoir 233: Clericy and La Pause Map-Areas, Quebec. By J. W. Ambrose. (No. 2465.) Pp. iv+86+4 maps. (Ottawa: King's Printer.) 25 cents. [33

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 30: The Effect of Environment on Fibre Maturity of Cotton. By A. N. Gulati. Pp. 16. (Bombay: Indian Central Cotton Committee.) 8 annas. [33

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6: (Monograph No. 4): Assistance on School Plant Problems as a Function of State Departments of Education. By Alice Barrows. Pp. vi+92. 15 cents. Bulletin 1941, No. 8: Voices of Democracy; a Handbook for Speakers, Teachers and Writers. Compiled by Bernard Molohon under the direction of Chester S. Williams. Pp. x+84. 15 cents. Vocational Division Bulletin No. 214 (Occupational Information and Guidance Series, No. 6): Vocational Guidance for Girls and Women; References and related Information. By Marguerite W. Zapoleon and Louise Moore. Pp. v+162. 25 cents. (Washington, D.C.: Government Printing Office.) [33

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COLONIAL DEVELOPMENT AND RECONSTRUCTION

THE importance of colonial development in relation to post-war reconstruction and Anglo-American co-operation has been widely recognized in several measures that have already been taken in furtherance of the new policy of colonial development and welfare outlined in the White Paper of February 1940, such as the establishment of the Leith-Ross Bureau and of the Hailey Committee. Lord Moyne has already been able to give an encouraging account of colonial development during the War, and in debates in Parliament dealing with labour questions and colonial welfare generally, suggestions for the further improvement of colonial administration, for example, by the appointment of a Standing Joint Committee of both Houses of Parliament, have been from time to time advanced. The International Labour Organisation devoted some attention at its conference in New York last October to labour problems in the Colonial Empire, and the place of colonial administration in Anglo-American policy was fully recognized before Japan launched her attack.

The recent reverses in the Far East have, however, brought colonial policy and administration into the forefront for urgent examination and drastic action.

The broadsheet on the "Future of the Colonies", which was issued early this year by Political and Economic Planning (P E P), is a suitable starting-point for the re-examination now demanded. The position in the south-western Pacific is only a special example of the general problem of colonial development, and a sound judgment on whatever mistakes in policy or administration may have been made in British Malaya cannot be reached apart from the broad background. Much of the defence and attack upon colonial administration in that area which have been developed seem to betray little sense of perspective, and to be unrelated to that broad strategic policy which is required both as part of our war effort and to implement the conceptions embodied in the Atlantic Charter. Five of the eight points of that Charter are directly relevant to the future of the Colonies, and while any elaboration of policies based on those generalizations presupposes the establishment of a durable peace and the creation of new international institutions, based on political realities, the initiation of such new forms of international co-operation is an indispensable part of the measures required to retrieve the position in the Far East.

In the development of tropical dependencies two problems are entangled : the need for development and the politically dependent status of the great majority of such dependencies. Both problems are resultants of their backwardness, cultural and economic, relative to the metropolitan countries, which has led to their being taken over as colonies by the more advanced nations. In considering the future of these areas, political, economic and social questions demand answers, and the fundamental problem is that of determining the relative emphasis and the desirable rate of change. We must determine not only the direction but also the tempo of advance.

Politically, we must first determine how far international regulation can be substituted for national possession, and, secondly, how best a movement towards responsible self-government can be encouraged. Economically, we must answer the questions how these areas can be developed so as to make their resources available to the rest of the world, and how the standard of living of the native peoples can be raised to enable them to play their part as markets for the products of other areas. Socially, we must determine first how to improve the health, the general relation of the individual to society, and the education and cultural development of native peoples, and secondly how Western techniques and ideas can be grafted on to an indigenous basis to secure social and cultural progress instead of disrupting native life.

Not only is it essential in tropical areas to discover the desirable rate of change, so that changes in one field may keep in step with other types of change, and assimilation and adjustment are possible, but it must also be remembered that such countries are only partly organized on a money economy basis, and most of their inhabitants have very low standards of life. Only where mineral resources are present have large financial returns in general been obtained, and many of these go directly to the metropolitan country. Disease, death-rates and the low educational level are other handicaps, and contribute to the persistence of backwardness, which is essentially a temporary phenomenon and should be regarded as an early stage in a far-reaching process of development, among the goals of which must be envisaged a high standard of life as well as self-government.

In regard to the political problem, it should be remembered that the foundations of European power in these areas were not in general laid by the deliberate action of Governments, but by the non-political action of traders. None the less, Colonies have always been a source of international friction, and, indeed, a special case of the friction between independent sovereign States of the modern type. Colonial friction cannot be abolished by any isolated treatment. As Schwarzenberger shows in his study of "Power Politics", Colonies form a special aspect of the relations of power and politics. The absence of a satisfactory moral basis for a dependent colonial empire, apart from the internal problem of meeting local aspirations for further self-government, would alone enforce the need, as part of a real world settlement, of developing a colonial system designed to eliminate the jealousies of the industrially advanced nations, to promote the development of tropical areas in the interests primarily of their own populations but also of the rest of the world, and to facilitate their progress towards self-government.

Of the concrete proposals towards that end, the PEP broadsheet dismisses as unsatisfactory the pooling of all Colonies under an international administration.

It is urged that the solution of the problem lies in the whole-hearted adoption by the colonial Powers of the principle of trusteeship, with all its positive and practical implications, including that of some degree of international supervision and regulation of colonial affairs. Implementing the trusteeship principle by practical schemes for economic and social development would remove the sources of political friction between the colonial and non-colonial Powers. The Colonial Development and Welfare Act of 1940 is, of course, a definite step in this direction, but large-scale international co-operation of various kinds will also be required, and other backward tropical areas, besides the Colonies in the strict sense, must be included in such schemes of combined social and economic development.

As further steps to abolish friction about the Colonies, and to promote greater uniformity in social and administrative standards in colonial areas, as well as to accelerate progress towards self-government and property, the broadsheet visualizes an extension of the mandate system into an international organization with an executive council, a reasonable central fund at its disposal, and an expert staff trained in an international staff college. Administration would remain in the hands of the existing colonial Powers, but a small proportion of technical posts should be thrown open at once to qualified men of any nationality, the selection to remain in the hands of the existing Power. This proportion should be gradually increased, and the process might be extended to administrative posts as men trained in the colonial section of the international staff college began to be available.

In addition, there must be guidance and supervision on the international level, and to secure international agreement on the interpretation of the trusteeship principle itself the promulgation of a Colonial Charter is suggested. This need affirm only the following points: (1) colonial dependencies are held in trust; (2) the primary aim of the trusteeship is to enable the dependencies to attain self-government as rapidly as possible; (3) the second major aim is the development of colonial territories primarily for the benefit of their own inhabitants; (4) the trusteeship is exercised jointly by all countries included in the international organization, but delegated so far as administrative responsibilities go to Powers with colonial experience; (5) no inherent or permanent inequality exists between races or peoples, and equal status and equal opportunity for all is a goal to be realized as speedily as possible; (6) all nations adhering to the international organization shall have equality of opportunity in the Colonies, subject only to the need for maintaining efficient administration.

The raising of minimum towards optimum standards will be best achieved by a series of international conventions, to be in general the concern of the International Labour Office, which should be strengthened by the foundation of a special Colonial Section. The establishment of a Colonial Commission of the international organization to secure a combination of efficient planning, advice and grants in aid of development is suggested, and this Commission should be provided with a small but highly trained international staff of experts and advisers. What is immediately required is the encouragement of sturdy, self-reliant local communities, with a liberal and increasing measure of self-government in economic and political affairs. As Lord Hailey has emphasized, not only in his great "African Survey", but also more recently in speeches in Parliament and elsewhere, the most urgent practical problem is that of raising the economic and social level of life in colonial areas.

This clearly means a revolution in our whole thought and attitude to the Colonies. The shift in emphasis from political to economic and social progress means more than economic planning in the narrower sense, the diversification of tropical economics and the raising of income and standards of life. It means close attention to the human resources, and particularly, well thought-out schemes of health and education. The importance of education in the broad sense in mitigating the bad effects resulting from the impact of white civilization on backward culture is not easily overstressed. Extension of experiments now being carried on by the Arts and Crafts Department at Achimota on the Gold Coast would lead naturally to the establishment of schools of social and economic survey and research, which, besides canalizing the enthusiasm and intelligence of the native *élite* as they become sufficiently trained, would provide, by carrying out field experiments, social and agricultural, a basis for the orderly development of social policy. Integration of higher education, including research, in European countries with that in the Colonies through large-scale interchange of personnel at various grades would be of particular value in preventing isolation and stagnation in the Colonies, and in stimulating interest at home in colonial problems.

The methods to be employed in furthering the general economic aim, however, must conform to three general principles. Each area should earn as much as possible towards building up its own essential services. Secondly, the maintenance of a proper standard of living should never be left at the mercy of local commercial interests or of the stresses and strains of world economic forces; a basic minimum standard should be guaranteed, however long it may be before the area can be developed to become self-supporting. Thirdly, all external commercial enterprise must operate to the benefit of the local population.

As to the machinery of tropical development, the broadsheet suggests that a Colonial Investment Board should be attached to the International Colonial Commission to influence and guide private finance into the channels most suitable for achieving colonial development. In addition to Government administration, co-operative producer agencies, such as the Empire Cotton Growing Corporation in the Sudan, and marketing agencies associated with international control schemes which already function, two further types of large-scale development agencies are envisaged: international public concerns, operating for profit under licence, and regional development agencies, not operating for profit. The former might be started where a local surplus is available and can find an external market, and it might take various patterns subject to welfare and conservation regulations approved by the Colonial Commission and to limitations on profits.

Regional development agencies, on the other hand, will be required in those numerous regions which require large-scale development before they attain a level of economic activity at which commercial profit can be expected. Their problem is as much social as economic, and involves the transformation of every aspect of life. When established they should be under international supervision, and apart from this their functions would closely resemble those of such a body as the Tennessee Valley Authority. Similarly, wherever one of the main products of a territory is controlled by an international commodity control scheme, a local producers' organization, with Government participation, will be required to represent the territory and to arrange for proper marketing facilities.

On the necessity of planning development in all backward areas on a long-term basis, to achieve smooth working, there can be no reasonable doubt, and the broadsheet equally endorses the "African Survey" in its insistence on the need for adequate survey and research as a pre-requisite to development in almost every field. Also it sees in the regional development of the equatorial territories of Belgium, Britain and Free France, Anglo-American co-operation in the Red Sea area and the Persian Gulf, and the Supply Councils for the Eastern Group, the Middle East and the Pacific Areas, a tendency towards the grouping of separate territories into larger units capable of supporting the expert staff required for such developments as are suggested. Besides this, it is essential that with the extension of international co-operation, and the delegation of more power and responsibility to administrators on the spot, the Colonial Office must include a section for the framing of broad policy.

It is no disparagement of British colonial achievements in the past or of the new policy represented by the White Paper of February 1940, to suggest that one good result of the defeats in Malaya and Burma may be a greater readiness to recognize that in the field of colonial policy and administration Great Britain has much to learn from the experience of others in the same field, and that in the pooling of experience the contributions will come not from one side alone. The breakdown of any such reserve is essential in the pooling of ideas, in participation in joint regional schemes, in projects for survey and research, in association on the International Colonial Commission and other ways by which the colonial Powers could rapidly establish a common policy of material, political and cultural development.

The bitter experiences of the East Indies may indeed result, not in useless recrimination or invidious comparison between Dutch and British practice, but in a close contact and pooling of experience which will enable us to construct a new regional order. Already there are signs that the Colonial Office is alive to many of the issues involved. The memorandum submitted to the International Labour Conference, Major Orde Browne's report on labour conditions in West Africa, the establishment of a special department on Labour and Welfare, and of a Labour Advisory Committee, are all indications of a new outlook and a greater readiness to learn from the experience of others, whatever doubts may sometimes be entertained as to the extent to which the new outlook has found expression in the field. Moreover, this is not a matter which is the concern of Great Britain alone. Apart from the great help which the United States can undoubtedly give generally, particularly in such areas as the West Indies, to implement a far-reaching constructive colonial policy, the co-operation of the British Dominions is also essential.

The problems of the Colonial Empire were discussed in two articles in *The Times* of March 13 and 14 by Miss Margery Perham. It is impossible to summarize them here; they should be read and studied carefully. Some points she raises have been taken up in correspondence by Dr. Raymond Firth and by Lord Moyne. Dr. Firth points out that for more than a decade anthropologists, educationists, historians and others have been amassing data relating to the Colonies, and that they have stressed the bad effects of labour migration, the economic difficulties of the native peasantry and the lack of educational opportunities. He envisages more adequate training of administrators, whether native or white, in economics and other social studies, recognition of the importance of science in coping with all aspects of colonial life, and wider understanding of colonial questions by the people of Great Britain. Lord Moyne discusses in particular the financial disadvantages under which colonial administration has functioned, condemning in particular the system whereby the white officials are, in effect, dependent on local budgets for salaries and pensions, so that the poorer Colonies, which need the ablest men, are automatically unable to employ them.

The dominant need at the present moment is for the examination of policy and administration in the remaining Colonies and Dependencies with the determination to eradicate swiftly and ruthlessly any mistakes or weaknesses revealed in the light of recent experience. We must also initiate without delay whatever measures may be required to capitalize their good will and moral as well as material resources in the service of freedom, and in the furtherance of a colonial policy designed to eliminate friction between the great Powers over colonial questions and enable each major colonial region to develop its own culture with the assistance of the science and thought of the Western Powers. If we can bring to this task the necessary magnanimity, vigour of mind, vision and firmness of purpose, we shall find that once again our policy and its execution serve both the immediate war needs and the furtherance of those changes designed to secure an enduring peace. Nor should it be forgotten that the achievement of such aims and the removal of the frustration which is the key-note of the dissatisfaction felt in the Colonies to-day, both by the advanced minorities and by recruits in the colonial service, involves a much wider and intelligent interest in colonial affairs by the people in Great Britain. Scientific workers who, as Lord Hailey's great survey has shown, have so large a part to play in colonial development, must not be backward in the work of educating public opinion that is involved.

THE THREE NEGATIVES OF THERMODYNAMICS

The Nature of Thermodynamics

By Prof. P. W. Bridgman. Pp. xii+229. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1941). 20*s*. net.

THE position of author and reader in this challenging book are those of two students of thermodynamics who have mastered conventional thermodynamics, and, having attained some degree of maturity in applying it, agree to confide in one another their various doubts and difficulties. In a pleasantly informal way, Prof. Bridgman discusses a variety of situations to which the easy application of thermodynamic reasoning is far from obvious; and the reader *may* end by becoming a sceptic. Nevertheless, the broad principles of thermodynamics emerge from their ordeal, on the whole, better than one feared. The attitude of the book is the reverse of complacency; it never says "physics teaches . . .", and it will have done good in showing that orthodox positions are never incapable of criticism.

The author's general purpose is the attainment of "understanding", and with this object he rejects any precise, logical, postulational formalism in favour of discursive argument. His topics are the three primary concepts: temperature, energy and entropy. But his procedure is not to treat them as indefinable concepts (cf. Bryan's treatment of energy in his famous "Article"), but to apply always the 'operational' method, that method which consists in defining quantities only through the material processes by which they can be measured. The method in effect originated in the British school of philosophy of Locke and Hume, but in modern days takes its inspiration from Einstein, who applied it with such brilliant success to the previously undefined concept of simultaneity. It has been developed at length by Prof. Bridgman in an earlier work.

The three thermodynamic notions above-mentioned are connected with three well-known negative statements of operational character—"postulates of impotence" as E. T. Whittaker has recently called them. Temperature is connected with the *inaccessibility* of certain states of a body from other states as a starting point, when the body is adiabatically enclosed. Energy and entropy are connected with the *impossibility* of constructing certain types of 'perpetual motion' machines. From these statements, the concept of a measure of temperature and the two laws of thermodynamics may be isolated. Prof. Bridgman truly remarks, in this connexion, that thermodynamics smells of its human origin: adiabatically walled bodies, and heat-engines, are constructions that do not "occur in nature", any more than the triangles of geometry. They are none the less proper subject-matter for theoretical physics.

Prof. Bridgman's operational method as regards temperature is akin to the above negative postulate. He shows that a variable (the "temperature on an empirical scale") is necessary to complete the description of the state of a body in addition to a set of independent mechanical variables equal in number to the degrees of freedom possessed by the body when in 'thermal' equilibrium with a given large body. The author says much to clarify the foregoing rough paraphrase, since the 'thermal' in thermal equilibrium needs explanation, and moreover we eventually use some *mechanical* variable such as length or volume to measure temperature. I am scarcely convinced that a 'heat-blind' person would gain a clear picture of temperature from Prof. Bridgman's account; but probably this would require that postulational treatment which the author is at pains to avoid.

With regard to the next negative, it is remarkable that Prof. Bridgman scarcely mentions the question of what is meant by the 'mechanical equivalent of heat'. We cannot test the First Law by means of the author's "surface sentries", until we have a value for J; yet we apparently cannot determine J without assuming the truth of the First Law. It is from the *proportionality*, of course, of heat gained to work lost that the idea of conservation of energy originates. But the author never says so. Instead, he spends much time on the hypostatization of energy, a tendency which I can only deplore. The author seems (in spite of disclaimers) to regard energy as having traceable identity: if it disappears at A, and appears at B, he is anxious to locate it on its way from A to B, and he therefore attempts to measure its *flux*, and to resolve the latter into a density and a velocity. One feels that Prof. Bridgman's engaging illustrations—the problems of the bent bar in motion (p. 45), of the moving rough block (p. 48) and of the gravitationally attracting spheres which are held apart by rigid connexions during their displacement (p. 107)—involve difficulties only because he insists on hypostatizing energy. Actually we know nothing of energy directly. To the operational method, energy is only known through performance of mechanical work (a more elementary notion than energy): when we perform work, either we create heat or we store up the power of securing work to be done for us in future, and thermodynamics gives the name energy to a certain linear function of the two which remains constant. The author appears to forsake the principles he is expounding when elaborating his ideas of energy-flow. He hypostatizes entropy similarly in its turn, but here the boot of criticism finds itself on its proper leg, for the student's usual difficulty is to think of entropy as a *thing* at all.

Prof. Bridgman repeatedly returns to the question of whether the macroscopic methods of thermodynamics or the microscopic methods of statistical mechanics are the more fundamental. He points out that all the basic microscopic variables are defined in terms of operations the practicability of which is derived from our large-scale experiences. He concludes that logically the thermodynamic method is the more fundamental. "The complete confidence of most physicists in their atomic analysis . . . overlooks the essential fact that logically the microscopic nas its origin in the macroscopic. Any suspicion of che adequacy of our macroscopic analysis should at nce arouse suspicion that our microscopic analysis s also inadequate." This is well said; in physics, to e iconoclastic of the macroscopic is to be defeatist. It may be mentioned that Prof. Bridgman is extremely appy in his account of the deficiencies of Maxwell's lemon.

In conclusion, it may be remarked that the laws f thermodynamics are not to be confused with the phorisms in which they are sometimes supposed to be xpressed. To say that the energy of the universe is onstant, or that its entropy increases, are operationlly meaningless phrases. We can only speak of the nergy of the universe at an instant when we have et up a standard of simultaneity; as this universe f ours contains, apparently, *motion* on such a large cale, simultaneity in the large is a matter of convention and of the scale of time adopted; hence to add together the energies of the separate parts of the universe at chosen instants is a purely conventional process; moreover, the universe (in my opinion) is probably not finite in number of particles. The difficulties with regard to energy are accentuated if we try to speak of the entropy of the universe, for to show that it increases we should have to compare entropies at two separate 'instants', and the simultaneity trouble crops up again worse than ever. It must be said that Prof. Bridgman adopts an exceedingly naïve cosmology in discussing the energy and entropy of the whole universe. Nevertheless, it is pleasing to find that he insists that before one can even attempt to speak of the energy of the universe, it is necessary to contemplate the separation of the universe into at least two parts, one of which contains the observer and his apparatus, and the other is the seat of possible energy transformations. I rejoice in this for the personal reason that some years ago I was castigated by a referee for pointing out a similar situation with regard to entropy: to measure the entropy change consequent on an 'irreversible' process, it is necessary to undo the process *reversibly* by heat transfers to and from a portion of the universe *external* to the seat of the irreversible process in question. Operational tests of the famous energy and entropy aphorisms of Clausius are thus most awkward. Prof. Bridgman's exposures of all the far-flung consequences of the operational method are highly stimulating.

E. A. Milne

THE RANDOM ELEMENT IN TIME SERIES

The Variate Difference Method

By Gerhard Tintner. (Cowles Commission for Research in Economics, Monograph No. 5.) Pp. xiv+175. (Bloomington, Ind.: The Principia Press, Inc., 1940.) 2.50 dollars.

NEARLY all time series, whether possessing trend or not, exhibit fluctuations of a more or less irregular kind. One of the first questions to be considered in analysing such series is how much of the fluctuation can be ascribed to purely random effects —random in the particular and important sense that a value at one point is independent of values at other points in the series. From the very nature of random variation it is impossible to calculate the random component at every point, except in the form of a residual which is left over when the systematic element has been abstracted; but it is possible to estimate the variance of the random element for the whole series on certain broad and plausible assumptions.

If a time series is differenced k times, the variance of the random element in the resultant series inincreases rapidly, being $(2k\,!)/(k\,!)^2$ times that of the original. On the other hand, the systematic element is reduced, or at least does not increase to the same extent, unless it is of very short period. If, therefore, a given series is differenced, and its variance divided by the factor $(2k\,!)/(k\,!)^2$, the result should tend to the variance of the random part of the original series. The elimination of systematic effects by differencing is the basic idea around which the theory of the variate difference method is built.

The method appears to have been used for the first time by Poynting in 1884 in a study of the relationship between wheat prices and silk—and cotton—imports into the United Kingdom. Since that time it has engaged the attention of many writers, not always favourably, and the mathematics of the subject have been worked out very fully by Prof. Oskar Anderson, whose treatment is followed by Prof. Tintner fairly closely.

This book is an excellent account of the whole subject and can be thoroughly recommended. Tintner explains the technique of the variate difference method in great detail but has relegated mathematics to notes and appendixes, with the result that the non-mathematical reader can assimilate and apply the method without being bothered by theoretical detail, but on the other hand with a full understanding of what he is doing.

There is one important point arising out of the interpretation of results given by the method which one would like to have seen brought into greater prominence. In economic time series the random variance is often found to be a surprisingly small proportion of the total variance of the series, frequently only about 10 per cent and sometimes as low as 5 per cent. The natural inference would be that the remaining 90 or 95 per cent is systematic and hence may be predictable. But this is not necessarily so. The variance shown as 'random' by the variate difference method is attributable only to effects, comparable to errors of observation, which do not lag from one year to another. An economic disturbance may be random in the sense that it is casual and unpredictable, but once it has occurred it may affect subsequent years, and if it does the variations in successive years are no longer independent. The result may be either to increase or to decrease the variance given by the variate difference method. This type of correlation between successive years is not uncommon and is an overriding difficulty in the interpretation of the results given by variate-differences. There are other points which have led authorities such as Udny Yule, Bowley and Persons to doubt the usefulness of the method; but Prof. Tintner gives full references to these criticisms, and his exposition of the subject is well worth a careful reading by anyone interested in the baffling subject of time series.

M. G. Kendall.

MIDDLESEX PLACE-NAMES

The Place-Names of Middlesex, apart from the City of London

By J. E. B. Gover, Allen Mawer and F. M. Stenton, with the collaboration of S. J. Madge. (English Place-Name Society, Vol. 18.) Pp. xxxiv+238. (Cambridge: At the University Press, 1942.) 18*s*. net.

The appearance of another volume of the English Place-Name Society is at all times welcome, but in these days more so than usual. The book, but for special difficulties easy to be imagined, would have dealt not only with the County of Middlesex, but also with the City of London. With regard to the latter some of the necessary unprinted sources had become unavailable, and not everything which the editors desired in the case of Middlesex could be produced from "places of safety". Add to this that the invaluable help of Prof. Ekwall, through the exigencies of war, was lacking, and it will be seen that certain additions to what is now published may possibly be forthcoming in due time. But when all is said, the book is a mine of information, and is written with the trained judgment and precise scholarship which the names of its editors and compilers guarantee to us. A most essential point; for the study of place-names has a fatal fascination for the man in the street; he rushes in where the learned will suspend judgment, and their cautious approach to such household words as Piccadilly, Pimlico and Soho is rather in the nature of a red rag to him.

The name of Middlesex—the province of the Middle Saxons—is somewhat of a disappointment in itself, implying a much more important territory than the little county we know, a county, moreover, which while witnessing to the early stages of the Saxon settlement never became prominent or produced any of the great men of the time. So that where Saxon personal names survive, as in Kensington, Islington or Ealing, we know nothing of Cynesinge, Gisla, or Gilla, nor are the more interesting survivals of tribal names much more enlightening. A thrill is, however, to be obtained from the cryptic Gumeninga Hergæ, preserving the memory of a heathen shrine where now stands that famous landmark the spire of the church of Harrow-on-the-Hill.

The general impression given is of a district of farmland and woodland, full of small settlements the owners' names of which, where early documents have come down to us, are to be verified now and again; but where no records earlier than the twelfth or thirteenth centuries exist, have been altered out of recognition, and can only be guessed at. The physical features of the district, which are not striking, account for another batch of place-names, and tend inevitably to repeat themselves, as in South African place-names, of to-day. There are obscurities here, as when names implying chalk, in a district where no chalk occurs, have to be considered, and the traditional derivation of Chelsea, as a "port where lime is landed", will not survive linguistic tests, and is here suggested to be due to "folk-etymology". Such popular explanations of place-names are disappointing, and instinctively avoided, as an easy way out, by the scholar. A later series of names, the origin of which is either humorous—as Eel-pie Island—or contemptuous—as the Isle of Dogs—come into the same unsatisfying category, and there is finally the list—only too long—of names for which no adequate explanation can be given. Among these it is sad to find that inevitable attraction, Cold Harbour, here dismissed as "of no particular archæological significance"—almost as much of a shock to the interested public as is the Charing of Charing-Cross, which long precedes Queen Eleanor, and refers to the bend which the river takes at this point. Nor can we do other than regret that Horace Walpole's Strawberry Hill, so redolent of its period, must own its descent from a house built by a retired coachman and dubbed by his candid friends Chopped Straw Hall.

The lists of street names given under districts rest on a much firmer footing, as is natural, and are invaluable as a record of recent development, the memory of which soon fades.

The book ends with a list of the elements, apart from personal names, found in Middlesex place-names. Only four of these, all river names, come down from the times before the Saxon invasions, and at the other end of the story are three of French origin. There follows a list of Saxon personal names, and a solitary Scandinavian; then field and minor names, and an appendix on Saxon charters of Hendon, Hampstead and Westminster. Once more, a mine of information

Charles Peers.

Statistical Dictionary of Terms and Symbols

By Dr. Albert K. Kurtz and Dr. Harold A. Edgerton. Pp. xii+91. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 12*s.* net.

THE authors have collected their data from a number of current text-books and periodicals, and have been aided by an advisory council comprising some of the best-known American statisticians. Only definitions and occasional illustrative comments are given. This is in no sense a source book like Mulhall's famous "Dictionary of Statistics."

There is undoubtedly scope for a book of this kind, if only to help in standardizing nomenclature. Indeed, one of the most striking things brought out by the present work is the variety of names applied to the simplest statistical concepts. No fewer than eighteen synonymous terms are given for the normal distribution. For the figure known to English statisticians as the "scatter diagram" there are a dozen equivalent terms of varying degrees of cacophony, etymological impurity and sheer inaccuracy, such as "scatterplot", "scattergraph" and "double frequency table". The authors have been very chary of exercising the lexicographic prerogative by condemning any of these expressions as bad usage.

There are errors of both commission and omission in this book. The Gram-Charlier Type B series (p. 70) is not the same as the Poisson series; Bayes' principle (p. 16) is not the same as Bayes' theorem; the tetrachoric functions (p. 176) are not the same, except for sign, as Hermite's polynomials (which, by the way, are due to Tchebycheff, not to Hermite); the function usually denoted by t is not the ratio of a statistic to its standard error (p. 174). Of the five definitions of "error" on page 56 the first is "the observed value of a variable minus the true value. Not to be confused with deviation from the mean", and the fifth is "same as deviation from the mean". No doubt both usages exist, but the caution against confusion reads rather oddly. Among the omissions may be noted the absence of definitions of serial correlation, distributed lags, orthogonal polynomials, conditional statistics, Latin squares, random sampling numbers, divided differences, Edgeworth's translated frequency curves, cumulants and characteristic functions.

A dictionary of this kind will be generally useful and it is to be hoped that subsequent editions will see the incorporation of the many improvements which are possible.

M. G. KENDALL.

In Search of Northern Birds

By Seton Gordon. Pp. 224+16 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1941.) 15*s.* net.

SETON GORDON has again recaptured the air and charm of the lonely hills and islands of the north, and in his usual inimitable style. Few naturalists have described these solitudes so often and so pleasantly. The descriptions of well-loved hills and islands are interspersed with observations on birds and beasts and flowers.

It is a wide range that Seton Gordon embraces in his search of these fastnesses, and his notes on winter-day wanderings have perhaps a special value to most of us who only know these places in summer. He takes us from Lambay Island (Rechru) in the Irish Sea, and from the Pembrokeshire Islands, through the Hebrides (with a note on the little Northumbrian Island of Coquet) as far north as Iceland. On the north coast of Iceland, near Akureyri, he saw birches twenty feet high. At Lake Myvatn the flies drive even the hardiest fisherman to abandon the splendid trout-fishing. In the Westmann Islands he reminds us of the gannet colony at Sulnasker, and we can add that we have seen gannetries also on the neighbouring islets of Geldungur, Hellisey and Brandur, making a pretty large colony of probably four thousand breeding pairs.

Back in the Cairngorms, Seton Gordon asks how is it that moss can survive under snow for perhaps more than a year. He tells us that at the present day the marten still survives in the far north-west of Scotland, while the wild cat is not in danger of extermination.

R. M. L.

Electric Power Stations

By T. H. Carr. Vol. 2. Pp. xv+440. (London: Chapman and Hall, Ltd., 1941.) 32*s.* net.

THIS book, which deals with the electrical equipment of power station plant, is a companion volume to the author's earlier work on the mechanical side of the subject, and the two together constitute a very informative survey of modern station practice. The subject arrangement of the present volume betokens the authority with which the author writes and it covers alternators, condensing plant, feed-heating and water-treatment plant, transformers and reactors, switchgear, cabling and cables, oils, station auxiliaries, electrical protective equipment, station lighting, commissioning and testing of plant, station organization, station costs, and fire fighting and A.R.P.

Broadly, the book embraces considerations of design, construction and operation, and it contains numerous line and half-tone illustrations and detailed calculations where desirable. Many tables are included and a bibliography is given at the end of each chapter to facilitate further study.

As Sir Leonard Pearce says in his foreword, the book will be valuable in enabling specialists to keep contact with branches of engineering other than their own.

Algebraic Solid Geometry

An Introduction. By S. L. Green. Pp. vii+133. (Cambridge: At the University Press, 1941.) 6*s.* net.

THIS little book, based on courses of lectures given to students of Queen Mary College, London, may be regarded as an attempt to reduce the subject of algebraic solid geometry to a minimum. There are six chapters, dealing respectively with co-ordinates and direction-cosines, the plane and straight line, the sphere, the central quadrics, the paraboloids and the cone. The number of diagrams is only fourteen, which is scarcely sufficient. The second diagram has to serve for two different theorems, and does not show all the points mentioned in them. The examples include several from recent examination papers of the University of London. The general impression conveyed by the book is that the author's primary object was to make the subject as easy as possible, but that he has been handicapped in this by having to consider also the need for economy in paper.

POST-WAR AGRICULTURAL RECONSTRUCTION

By G. V. JACKS
Imperial Bureau of Soil Science

THE Division for the Social and International Relations of Science of the British Association held a Conference in London during March 20–21 to discuss problems connected with the post-war reconstruction of agriculture in Europe. Representatives of most of the occupied countries attended, and many addressed the Conference. A remarkable unanimity was evident in the diagnoses of the causes of pre-war agricultural troubles and in the formulation of the desiderata of reconstruction. All agreed that the best hopes for the future lie in the development of small-scale peasant farming concentrating primarily on livestock, fruit and vegetable production, this being a type of agriculture that would best serve to absorb the abundance of available labour, to raise national standards of living and of nutrition, and to enable European economy to play a more harmonious part than hitherto in world affairs.

At the first session, which was opened by Sir Richard Gregory, President of the Association, the need and aims of agricultural reconstruction were discussed. Sir John Russell, from the chair, said that one of the most immediate needs that will have to be satisfied is the provision of fresh seed and livestock for the devastated regions, and he suggested that schemes for collecting supplies should be initiated forthwith, particularly in North America, where the wide range of soils and climate enable all the kinds of seed required to be propagated. Sir John, like all the speakers, sees the best prospects for the successful rehabilitation of European agriculture in a greater production of 'protective' foodstuffs at the expense of cereals.

Mr. Kenneth Brooks gave an account of the European relief activities of the Society of Friends after the War of 1914–18. From the experience then gained he drew four main conclusions: (1) that it is impossible to separate relief from rehabilitation; (2) that short- and long-term policies in agriculture must be developed concurrently; (3) that international co-ordination of monetary and fiscal policy is essential; (4) that the quality of human sympathy in the administrative personel is at least as important as professional qualifications. A paper by Mr. Mikolajczyk, Deputy Prime Minister of Poland, indicated, by reference to present conditions in his country the immensity of the difficulties which will confront relief workers after the War.

Dr. B. Cubrilovič, approaching the subject from the economic point of view, maintained that a planned international economy with human welfare rather than profit as the objective must form the basis of any scheme of permanent reconstruction. Agriculture cannot be planned apart from industry, nor can a plan succeed which does not admit that the welfare of Germany is complementary to that of eastern Europe.

An account of predominantly small-scale farming in a densely populated country was given by M. L. Borremans, from Belgium. Under German occupation, grain production is being excessively stimulated at the expense of livestock and mixed farming. There will be urgent need after the War to restore the intensive production of protective foods and livestock, and to re-develop the processing industries.

At the second session a discussion on economic problems was opened from the chair by Mr. F. L. MacDougall, who referred to the work of the League of Nations Nutrition Committees, which are now taking up problems connected with post-war reconstruction. He feels that the basis of reconstruction should be the attainment of the four freedoms of the Atlantic Charter, and in particular freedom from want. The most serious nutritional deficiencies have occurred in those countries producing cereals for export. Post-war Europe will require an immense expansion of livestock farming; wines and fruit might advantageously replace wheat as the main export of south-eastern Europe. He thinks that a regional authority, on the lines of the Tennessee Valley Authority, operating independently of political boundaries and with wide powers to integrate riparian activities and co-ordinate them with other forms of production, might be set up in the Danube basin. But the basis of any such scheme must be adequate nutrition, the attainment of which is not precluded by any natural factor from any European country.

Dr. D. Mitrany advocated the cause of the peasantry against the views of the classical and Marxist economists, who affirm that the peasant is an anachronism, on the assumption that the basis of agricultural evolution must be a steadily increasing demand for wheat and other large-farm crops with the growth of industrialization. But since European wheat can never compete successfully with wheat grown extensively in the newer countries, emphasis in Europe is swinging from quantity to quality production, that is, to types of farming pre-eminently suited to peasant proprietorship. The Nazi aim of European self-sufficiency would mean the death of the peasant; the alternative—a higher nutritional standard and co-operation with overseas grain producers—could be achieved by a greater development of mixed peasant farming. Mr. N. Barou described the development of collective farming in the U.S.S.R., where the small private holdings held by the workers have been found to afford a necessary outlet for the individualism which is as characteristic of the collective farmer's nature as it is of that of the peasant.

Dr. R. Bičanič said that over-population of the land in eastern Europe has resulted in poverty, exploitation, excessive subdivision of holdings and consequent inability to effect any agricultural improvements. He believes the net effect of the War will be to increase over-population. Suggested remedies include the allocation of more land to the peasants and its more equitable distribution, intensification of mixed farming, the development of rural industries and the undertaking of public works on a large scale. There is need for great speed in making these changes, which will produce revolution unless they are made as part of a carefully planned economy within an international frame.

Mr. P. Lamartine Yates took Danish agriculture as an illustration of how a large population can be supported on naturally poor land at an exceptionally high standard of living. He associated Danish rural prosperity with the high proportion of intensively farmed arable land together with a livestock population much greater than could be fed off home-grown fodder, and in particular with the high level of education of the farmers. The advancement of agriculture in more backward countries depends as much on broadening the basis of education and raising the standard of intelligence of the people as on any of the economic and agricultural remedies mentioned at the Conference.

The future betterment of European farming was discussed on the second day at sessions presided over by Mr. A. J. Drexel Biddle, the American Ambassador to the occupied countries, and by Sir John Russell.

Miss Margaret Digby recapitulated the causes of agricultural backwardness advanced by speakers on the previous day, and emphasized the military reasons for State policies aiming at keeping an excessive population on the land. She called for a reconstruction programme based on high nutritional standards, more efficient farming, freer trade within a planned international economy, freer movement of populations and a wide development of rural industry.

Dr. L. Feierabend believes that agricultural evolution in Europe must be in the direction of small, individually owned farms working co-operatively. He distinguished clearly between co-operative and capitalistic farming. The primary aim of a co-operative society should be not the making of profits, but "the support of the business of its members", that is, the improvement of the land. He agreed with other speakers that a high standard of education is a necessary element in the success of any co-operative scheme. Mr. S. Malessa stressed the interdependence of agricultural and industrial planning. The problem of rural overpopulation can only be solved by industrial planning to absorb the surplus.

Dr. L. Dudley Stamp outlined the geographical factors determining and limiting the types of crop production feasible in Europe, and advocated planning on a regional rather than on a political basis. Dr. J. Krnjevič described the political emergence of the Croatian peasantry, comprising 90 per cent of the population, through the cultural activities of the Croat Peasant Movement.

Dr. J. Hammond gave an account of artificial insemination, which several speakers thought could play an invaluable part in restoring the quality and quantity of livestock. Mr. A. Fjelstad dealt with practical problems of the small livestock farmer in Norway, and Mr. P. H. Pedersen with practical aspects of milk production in Denmark. Both the last two speakers stressed the importance of effective co-operation in small-scale, intensive farming.

QUANTUM THEORY AND DIFFUSE X-RAY REFLEXIONS

By G. D. PRESTON
National Physical Laboratory

THE origin of certain anomalous X-ray reflexions, that is to say, intensity maxima the presence of which cannot be explained by the usual diffraction theory, has recently been the subject of investigation in many laboratories. Some account of the work carried out in Great Britain was given at a discussion held in London on February 6, 1941, and a review of this discussion appeared in NATURE of April 19, 1941, p. 467; a fuller account has been published in the *Proceedings of the Royal Society*, A, 179, 1–102, 1941. The progress made in the investigation of this interesting subject in India has recently been reported in the *Proceedings of the Indian Academy of Sciences* of October, 1941, which is wholly devoted, to quote from the cover, to a "Symposium of papers on the Quantum Theory of X-Ray Reflection and the Raman Reflection of X-Rays in Crystals". This description of the subject-matter reflects very clearly the difference in the interpretation of the phenomena which exists between French, American and British physicists on one hand, and the group of Indian physicists at Bangalore working under the leadership of Sir C. V. Raman on the other.

Before considering the nature of this difference of interpretation, it will be convenient here to indicate the scope of the papers presented to the symposium. Sir C. V. Raman contributes two papers on the theoretical aspect of quantum X-ray reflexion, and in collaboration with Dr. P. Nilakantan provides experimental confirmation from a study of diamond, a crystal the reflexion from which is also discussed by P. Rama Pisharoty. Dr. C. S. Ventakateswaran contributes six papers; one illustrates the change of intensity of the anomalous reflexions at low temperatures and the remainder deal with the patterns formed by rock salt, naphthalene, benzophenone and hexamethyl-tetramine. Benzil is investigated by R. V. Subrahmanian, and aluminium and calcite receive attention from Bisheshwar Dayal, P. Nilakantan and P. G. Nayar. This brief outline of the field covered on the experimental side will serve to show that, whatever differences of opinion exist as to the origin of the reflexions, the phenomena investigated are in fact the same as those studied in France by Laval, in the United States by Wadlund, Zachariasen and Siegel, and in Great Britain at the Royal Institution and the National Physical Laboratory.

It is perhaps worth while here recalling the salient features of the effects observed. When a single crystal of, say, aluminium, rock salt or sylvine is mounted in a beam of X-rays which traverse the crystal in a direction parallel to a cubic axis, a Laue photograph is obtained if the beam consists of 'white radiation'. In addition to the Laue spots, there appears on well-exposed plates a number of streaks, running through the Laue spots, which apparently should have no business there. When the composite X-ray beam is replaced by a monochromatic beam, the usual theory of crystal diffraction tells us that no reflexion should be observed unless the crystal is orientated in a particular way. In general, the condition for reflexion will not be satisfied, except by a lucky accident, and a blank photograph should result. However, in fact, reflexions are observed. They are faint, but have the symmetry proper to the crystal axis in which the incident X-ray beam lies. Examples have been published in the pages of NATURE (143, 76 (1939); 147, 467 (1941); 148, 112 (1941)). It is this background of 'non-Laue' diffuse reflexions that is attracting the attention of X-ray crystallographers. To what is it due?

There appear to be several possible answers to this question. The most comprehensive is perhaps to say that the diffuse background arises as a direct result of departures from geometrical perfection in the crystal architecture. A periodic flaw, a regular precipitation of an impurity such as produces a Widmanstätten pattern, and the temperature vibrations of the atoms are all possible and probable causes. It is the task of the experimenter to devise means of identifying the different causes so that use may be made of the machinery provided by the mathematician to enlarge our knowledge of the solid state. Those features of the background reflexions which occur in crystals of pure substances, so that flaws and chemical segregation are excluded from consideration, are evidently of great importance. There is general agreement on all sides that this background is due to movement of the atoms or molecules of the crystal from their positions of perfect geometrical alinement. The differences of interpretation arise in assigning the cause of the movement and in the mechanism of X-ray scattering. In Great Britain and in the United States, the whole effect is ascribed to the thermal vibrations of the crystal lattice. Just as the Laue and Bragg reflexions are a picture of the static geometry of the crystal, so the diffuse background is a picture of the dynamic vibrations of the crystal. The undisturbed crystal can be regarded as a medium in which the density varies periodically in space, and the effect of the temperature vibrations is to superimpose a spectrum of much longer elastic waves on the natural periodicity of the crystal. The whole crystal then diffracts as a unit and the resulting pattern consists of the usual Laue reflexions plus a background due to the motion of the atoms.

The point of view adopted by the Bangalore group of physicists is rather different. In places I find it obscure and can only hope that the following brief paraphrase of their views does them no injustice. To begin with, the quantum aspect of the interaction of X-rays with the atoms of the crystal is emphasized. The radiation scattered from an oscillating atom is stated to consist of three components, the amplitudes of which depend on the amplitude of oscillation of the atom, and which differ in frequency. The first component, which gives rise to the normal reflexions, has the frequency ν of the primary X-ray beam, while the other two have frequencies $\nu \pm \nu'$, where ν' is the frequency of the atomic oscillation. The frequency change is unfortunately too small to be measured directly.

The atomic oscillations which produce the frequency modulation are supposed, according to Raman, either to arise as a result of direct excitation by the incident beam or to be present as thermal vibrations. The existence of the latter does not seem to be essential; it is sufficient that the atoms are capable of being set in motion by absorbing energy from the X-ray beam—the interaction of the primary X-ray beam with the oscillating atoms then produces the effect. The character of the possible atomic movements is classified into two essentially different parts falling in the infra-red and the elastic ranges of frequency respectively. Raman imagines the elastic low-frequency vibrations of the crystal lattice to arise from the displacement of the lattice cell as a whole from its equilibrium position. Interaction between these vibrations and the X-ray beam gives a background of diffuse scattering of low intensity proportional to the number of lattice cells irradiated. The scattered energy is spread over a wide range of angles so that the elastic waves, it is stated, cannot produce a sharp reflexion.

To the infra-red modes of vibration is ascribed the principal role in producing the observed reflexions, with intensities proportional to the square of the number of lattice cells. These modes of vibration are supposed to arise from the movements of the atoms within the cells of the lattice. There is a difficulty here: the classification of the vibrations will hold for molecular crystals such as benzil, say. In these we might suppose the (infra-red) vibrations of atoms within one molecule to be controlled by forces different from those which control the vibration of the molecules as a whole (elastic waves). But in metal crystals we can choose a cell containing but one atom, and there is no distinction to be drawn between the vibrations of the atoms as a whole and those of the lattice. The metals aluminium, sodium and lead all show, however, pronounced diffuse reflexions, although the elastic waves are not supposed to be capable of producing such an effect. Moreover, Raman explicitly assumes, as a limiting case it is true, that the infra-red vibrations have identically the same frequency, amplitude and phase in all the lattice cells of the crystal: in order that the centre of gravity of the cell may remain fixed, some atoms must move in opposite directions to others, an idea that leads to difficulties as the number of atoms in the cell diminishes.

When the assumption just mentioned as to the identity of phase of the infra-red vibrations in all lattice cells is abandoned, it is assumed that the phase varies slowly from place to place in the crystal. We are then presented with the difficulty that the variation of phase is propagated through the crystal, a process which must involve the elastic properties of the lattice; yet these are supposed to be without effect in producing the most salient features of the X-ray pattern.

It seems unlikely that the quantum hypothesis as set out by Raman can be reconciled with the elastic wave explanation unless one or other hypothesis is radically altered. Although Sir C. V. Raman is confident that his quantum mechanism is essential, it must be admitted that the "thermal-elastic" theory does give a reasonably accurate account of the observed facts.

OBITUARIES

Prof. L. J. Henderson

BY the death of Lawrence Joseph Henderson, the U.S. National Academy has lost its foreign secretary, Harvard University a notable personality, and the United States an outstanding man of science.

Henderson was born in 1878. He graduated at Harvard in arts and medicine. A couple of years were spent in Strassburg, principally in Hoffmeister's laboratory, but he spent some time acquiring technique in organic chemistry in Thiele's institute, and his mind at that time was in close contact with that of Faust and the work of Schmiedeberg's laboratory. On returning to Harvard, Henderson was made lecturer in biological chemistry; in 1910 he became assistant professor, and in 1919 professor.

A remarkable range of knowledge enabled Henderson to contribute in ways not open to those whose intellectual background is more restricted. Versed in the disciplines of mathematics, science, and philosophy, he could place a physiological problem either in a more mathematical or a more philosophical frame than could most of his contemporary biologists. On the other hand, the manipulative aspect of experimental science made little appeal to him, and probably the particular satisfaction of 'bringing off' a difficult experiment was something which he was content to leave to others.

About the time when Henderson graduated, the buffering of fluids was one of the growing points both of physical and biological science, and Henderson's first notable work dealt with that subject (for example, "Das Gleichgewicht zwischen Basen und Säueren im tierschen Organismus", *Ergeb. der Physiol.*, 8, 254). The milestone which marks that phase is the "Henderson-Hasselbalch equation", stating that the hydrogen ion concentration of a solution containing carbonate, bicarbonate, and carbon dioxide is proportional to the ratio of the free to the combined carbonic acids. Perhaps his greatest contribution was his description of blood as a physico-chemical system. He described the red corpuscles in terms of the concentrations of eight components so connected that the alteration of any one equilibrium invoked a consequential alteration in all the others. This doctrine Henderson elaborated in his classical book "Blood"—the written record of his Silliman Lectures—in which, both for normal blood and that characteristic of certain diseases, the consequential inter-relations of the various factors involved were set forth in more than one hundred nomograms.

To such a mind as Henderson's, it was possible to treat of this great field without acquiring any mastery of the precise experimental techniques by which the data were obtained. It sufficed for him if the data which he plotted were reliable. He therefore, in collaboration with van Slyke, organized a large circle of extremely able experimenters, some in New York, some in Boston, and some farther afield, who undertook the necessary analyses.

It was not possible, however, for Henderson to treat of the physico-chemical blood picture, or rather blood kaleidoscope, without being intensely interested in the philosophical relation of environment to the change which it wrought in the blood of the organism. This interest was responsible for two books, "The Fitness of Environment", and "The Order of Nature". soThe study of environment at once locates Henderson's veneration for Claude Bernard, and the name of Claude Bernard leads to Henderson's love of France. He particularly enjoyed the tenure of exchange professorships at Paris and Grenoble. He held the Legion of Honour, and was a foreign member of the Académie de Médecine (Paris). He travelled on French ships, and enjoyed French wines and French cookery. Henderson was no mean cook himself; indeed, during the war years of 1917–18 he was a constituted American authority on the properties of gluten and the science of baking. Other books were "The Fitness of Environment, and "Pareto's Sociology".

Henderson was a wonderful friend and a wonderful host, particularly perhaps at his summer camp, at Morgan's Center in Vermont. He loved to entertain his friends, and so did his wife. Morgan's Center is in hilly country—country which had once been in cultivation, but now has relapsed to a birch wood. Here on the edge of the lake, the very edge (so that you can dive in from the verandah), was the central cottage where one ate and smoked; the premises expanded on what Henderson called the 'village system', which meant that he bought some window frames from a Chicago stores, and the local carpenter built a hut of perhaps a couple of sleeping rooms around the windows.

The nineteen-twenties were prosperous years in the United States, and the loyalty of her sons saw to it that Harvard participated in full measure. Under the wise guidance of President Lowell it was a time of great expansion on both the scholastic and social sides. In the planning of this expansion Henderson took a very important part—a part for which his wide academic outlook on one hand, and his great social gifts on the other, made him peculiarly valuable. Chairs were created, departments came into being on a basis of wide culture; among these must be mentioned the Fatigue Laboratory of the Harvard School of Business Administration, which dealt largely with muscular fatigue, in its widest sense, and the establishment of a human base-line in such matters; this was Henderson's peculiar *pied-de-terre*. On the social side the expansion took the direction of an endeavour to incorporate into Harvard what was socially desirable in the older English universities while in no wise doing violence to Harvard itself. While, therefore, Harvard still remained Harvard, new houses of residence sprang up, each presided over by a Master, and named after great Harvard men of former times. Thus there was a considerable increase in the number of men—as we would say—'in College'. But among the other new features of the Harvard constitution was one particularly precious to Henderson, one for which he was largely responsible, and one of which he was himself chairman, "The Society of Fellows"*.

This tribute would be incomplete without a reference to Henderson's intense desire to knit more closely British and American science, and probably he did much more than appears in successfully accomplishing this. Yet his work was a broader one; it was to knit British and American culture, indeed to knit Britain and America themselves, not perhaps formally, but none the less really. It is significant that only illness prevented his giving the Pilgrim Lecture in London.

Lawrence Henderson received many foreign recognitions of his work, including an honorary Sc.D. in Cambridge. He married Edith Lawrence Thayer in 1910 and leaves one son.

A few weeks ago Sir Charles Sherrington passed a photograph of Lawrence Henderson hanging in the Laboratory. He glanced at it and said, half to himself, "A great man, that."

J. Barcroft.

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* The term 'fellow' is used in at least three senses at Harvard. (1) The charter of 1650 vested "sundry guiftes legacies landes and Revennewes in the President and Fellows". Now, the Corporation consists of the President, five fellows and a treasurer, who in the last resort act subject to the Board of Overseers elected by the graduates. (2) The Society of Fellows, consisting of nine senior fellows, of whom the President of the University and the Deans of the Faculties of Arts and Sciences are *ex-officio*, while the chairman (lately Lawrence Henderson) and six fellows are elected by the Corporation and confirmed by the Board of Overseers. The senior fellows select junior fellows and recommend them to the Corporation for appointment. "These men are selected for their promise of notable contribution to knowledge and thought. . . ." A junior fellow has free board-residence in a house and an annual emolument of 1,250–1,500 dollars. (3) Numerous fellowships also exist in connexion with the faculties which are of the nature of senior studentships.

Prof. Walter Nernst, For. Mem. R.S.

IN the passing of Walter Nernst, Nobel laureate, physical chemistry has lost a notable leader. From 1894 he was professor at Göttingen, from 1905 in Berlin, afterwards, until 1924, director of the Reichsanstalt, and from 1925 until his retirement director of the Physical Institute in Berlin. After training as a physicist he became assistant in Ostwald's laboratory in Leipzig, where he was additional professor in 1891, and his earlier work was concerned with the broadening and deepening of what was then the 'new' physical chemistry, which centred around the theory of electrolytic dissociation and was so enthusiastically received and developed in the Leipzig school. Ostwald turned more and more from the atomic and molecular conceptions then ruling in chemistry, and sought to replace them by "Energetics", or non-hypothetical laws based on the transformations of energy. Nernst always insisted, on the contrary, that thermodynamics and molecular theory must hold equal rank in a complete interpretation of physico-chemical phenomena. This is the key to nearly all his work, and is reflected in the title of his text-book: "Theoretical Chemistry from the Standpoint of Avogadro's Rule and Thermodynamics".

Of the large number of subjects which Nernst investigated, it is only possible in a brief notice to mention some in which he appears as a theorist and experimenter of great originality. These include his work on electrochemistry, the heat theorem and the quantum theory of solids.

In the electrochemical researches, three groups are most prominent. The first was the theory of the galvanic cell based on the idea of electrolytic solution pressure—the tendency of an electrode to throw out charged ions to a limit balanced by the osmotic pressure of the solution, and so to develop a potential difference. The formulæ based on this are still the foundation of the theory of electromotive force. Incidentally, his proposal to use the hydrogen electrode as the standard of electrode potential is still in use. Closely related to this work is that on the potential differences set up between solutions of electrolytes in contact. The theory of the effect of an electrolyte on the solubility of another having a common ion ('solubility product') threw light on many branches of chemical work, and the so-called distribution law, giving the way in which a substance distributes itself between two non-miscible solvents, is one of the most important in the study of heterogeneous equilibrium.

In his treatment of thermodynamics, Nernst made use of Helmholtz's equation relating the diminutions of energy (U) and free energy (A) in a process with the temperature coefficient of the free energy (dA/dT), itself equal to minus the entropy increase ($-\Delta S$), namely, $A-U=T. dA/dT$. He used this equation with great ingenuity in various fields, and its form lent itself very well to the discovery of the famous Nernst Heat Theorem (sometimes, and by Nernst himself, called the Third Law of Thermodynamics). By an inductive process, based on an extensive knowledge of the experimental results—another characteristic of his procedure—he singled out a field of changes in which the equation $dA/dT=0$ approaches exact validity as the temperature approaches the absolute zero. This implies that $A=U$, and many years previously he had pointed out that this—the so-called Thomsen-Berthelot principle—had a kernel of truth, which could never be disclosed apart from the numerical data. The Nernst Heat Theorem was at first mostly used in the calculation of chemical equilibria from thermal results. In its later developments its intimate relation with the theory of entropy and statistics has been made clear.

It was characteristic of Nernst that he quickly appreciated new discoveries and theories, and that he usually recast the theory into a more intelligible and practical form which appealed directly to chemists. The quantum theory, which was strangely overlooked in England, he recognized as likely to transform many branches of physical chemistry, and in two directions, in photochemistry and the theory of solids, he turned it to most fruitful applications. In the experimental work on the heat capacities of solids at very low temperatures he showed great skill in devising new apparatus—including the use of a metal block as the calorimetric substance—and gave a firm foundation to the quantum theory of specific heats. He invariably strove towards simplification and elimination of redundancy both in theory and in apparatus, and in this work liquid hydrogen was made available in quantity by means of a very simple and effective apparatus at a time when it was regarded as a rarity in most laboratories. He was also interested in the technical applications of physical chemistry, and the Nernst lamp well illustrates his practical ingenuity.

Nernst's work lies at the foundation of many branches of physical chemistry which are most actively studied at the present time, and all physical chemists recognize his outstanding contributions to their science. J. R. P.

Rev. H. J. Riddelsdell

Harry Joseph Riddelsdell entered business after school, but studying in his spare time took the B.A. degree of London and gained an exhibition at Jesus College, Oxford, where he graduated in honours and won the Hall-Houghton Prize. He took Holy Orders, and after holding a curacy at Leeds parish church became sub-warden of St. Michael's College, Llandaff, a post he held for seventeen years. In 1914 he was appointed rector of Wigginton and later became vicar of Bloxham. He retired from parish work in 1936 and died on October 17, 1941.

Riddelsdell's long residence in the country gave opportunity of using his quick eye and active mind in observation of Nature, and enabled him to make a thorough study of the flora of the neighbourhood. In 1907 he published "A Flora of Glamorgan", and from 1901 he contributed numerous notes to the *Journal of Botany* and other periodicals. He was a frequent contributor to the Botanical Exchange Club and sent valuable notes for the annual reports. The difficult and critical brambles became a special subject under the guidance of the Rev. W. Moyle Rogers, and after the death of the latter Riddelsdell became the leading authority on the genus in Britain and determined specimens for collectors. He visited many parts of Great Britain for the purpose of this study and a number of new forms were described.

The work to which Riddelsdell gave most of his leisure and ripe knowledge was the flora of Gloucestershire, sponsored by the Cotteswold Naturalists' Field Club. From 1908 as editor he organized and directed the work of Club members and dealt with the large quantity of lists and records already accumulated. A final revision had begun when illness compelled him to leave the task unfinished.

Riddelsdell was first and foremost a faithful and scholarly servant of the Church, devout and unselfish and loved by all around him. In addition, his energy, enthusiasm and quick apprehension enabled him to accomplish much in his leisure and made him a delightful companion in the field. He was elected associate of the Linnean Society in 1925 and his valuable herbarium is preserved in the British Museum (Natural History). W. C. Barton.

We regret to announce the death of Captain Guy Dollman, assistant keeper of zoology (first class) in the British Museum (Natural History), on March 13, aged sixty-five.

NEWS and VIEWS

New President of the American Association

Prof. Arthur H. Compton, Charles H. Swift Distinguished Service professor of physics in the University of Chicago, was elected president of the American Association for the Advancement of Science by the council at its meeting held on December 31. Prof. Compton is well-known for organizing and carrying out world-wide investigations of the reception and properties of cosmic rays, and for the influence he has had on education. He is a member of a family that has become famous in one generation, his brother, Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, having been president of the Association in 1935, and his brother, Dr. Wilson Compton, having been a member of the Finance Committee of the Association during 1933–41. Dr. Arthur Compton was born in Wooster, Ohio, forty-nine years ago. He graduated from Wooster College in 1913, took his Ph.D. degree at Princeton University in 1916, and he has received honorary degrees from several universities. He has been on the faculty of Wooster College, Princeton University, the University of Minnesota, Washington University, and finally in the department of physics of the University of Chicago since 1923. Dr. Compton was a research physicist of the Westinghouse Lamp Company during 1917–19, a national research fellow at the University of Cambridge during 1919–20 and has been special lecturer at several foreign universities.

Thousand Dollar Prize of the American Association

The nineteenth Thousand Dollar Prize of the American Association for the Advancement of Science was awarded at the recent meeting in Dallas to Drs. Dugald E. S. Brown and Douglas A. Marsland, of New York University, and Dr. Frank H. Johnson, of Princeton University, for two joint papers: (1) "The Reversible Denaturation of Enzymes as a Determining Factor in the Reaction of Biological Systems to Temperature and Pressure" and (2) "The Mechanism of Temperature and Hydrostatic Pressure Reversal of Narcosis in Luminous Bacteria". In these papers an interpretation for the reversible biological effects of pressure is presented, and the quantitative evidence seems to be fully conclusive and is directly referable to basic principles of thermodynamics. In solving the problem of pressure, evidence has been found for a new general understanding of temperature relations in biological processes. A new concept, also supported by clear-cut evidence, is introduced with regard to the mechanism of narcosis. Thus a common denominator appears to have been found for three fundamental factors in biological processes—pressure, temperature and narcosis—wherein diverse effects can now be related to the same fundamental mechanism, itself in accord with familiar laws of physical chemistry.

Dr. Brown was born in St. Thomas, Ontario, in 1901, and studied at the University of Michigan and received the Ph.D. degree from Cornell University. Dr. Marsland was born in Brooklyn in 1899 and received the B.S. and Ph.D. degrees from New York University and the M.S. degree from Columbia University. Dr. Johnson was born in Raleigh, N.C., in 1908 and received the A.B. and Ph.D. degrees from Princeton University and the A.M. degree from Duke University.

First Publication of the Geological Society

At the meeting of the Geological Society on February 25, Dr. Leonard Hawkes reported the discovery in the Library of the Sedgwick Museum, Cambridge, of the first publication issued by the Society, a pamphlet of 20 pages, entitled "Geological Inquiries". The "Inquiries" were drawn up by a Committee in February 1808, three months after the foundation of the Society, and circulated among the members. At the time when Woodward's "History of the Geological Society of London" was published (1907), it was thought that no copies had been preserved. The pamphlet opens with an "Introduction" dealing with the scope and purpose of geology and with plans for the development of the science. In this we read that "Geology relates to the knowledge of the system of our earth, of the arrangements of its solid, fluid, and aeriform parts, their mutual agencies, and the laws of their changes".

The inquiries, of which there are 130, were collected from various sources "with a view to facilitate and in some measure to direct general research" in the hope "that by the labours and talents of many individuals thus united and assisted, several important objects may easily be attained"; and "above all, a fund of practical information obtained applicable to purposes of public improvement and utility". The following are examples of the inquiries: "Concerning Vallies [*sic*]. Do the opposite sides consist of the same kind of rock, and do they correspond in the inclination of their beds or strata ?" "Concerning Organic Remains. Do particular shells, etc., affect particular strata ? Are the shells worn, broken, crushed, or thrown out of their natural position ? Are the different species confusedly intermixed ? Among the various organic remains, can any traces be observed of the existence of man ?"

Raw Materials in the New World Community

The collective organization of all human beings into some form of world community, with a planned co-ordination of human activities of all sorts, was predicted as a result of the War by Prof. Kirtley F. Mather, professor of geology in Harvard University, at the Cranbrook Institute of Science on January 30. He considers that, regardless of the outcome of the War, the old order will inevitably be replaced by a new order that is even now being formed. This organization of individuals into a world society is the inevitable consequence of the extensive use of natural resources that are unevenly distributed over the face of the earth. The ceaseless flow of things from mine and quarry, field and forest, to processing plants, mills and refineries and thence to consumers is a fundamental necessity in an age of science and technology. It is quite likely that the historian of the future will rate this middle third of the twentieth century as equal in significance to the closing third of the fifteenth century. To-day, just as in that ancient time, human civilization is moving from an era that is closing into a new era that is opening.

There is actually an abundance of the needed raw materials, Dr. Mather said. A careful appraisal of the world stores of non-renewable resources, including known substitutes for such resources as petroleum that are known to be present in insufficient amounts, reveals the fact that there is enough and to spare of all the necessary raw materials to provide the physical basis for the efficient, comfortable existence of every human being who is likely to be born anywhere on the earth during the next two thousand years at least. Science and technology are even now inaugurating a new relationship between man and the things he needs or thinks he needs. For a century or more the tendency has been to use more and more of the non-renewable resources, Nature's stored capital, and relatively less of the renewable resources, man's annual income. For example, between 1900 and 1925 we used up more of the world's resources of the various metals and mineral fuels than had been used by man throughout his entire history prior to the year 1900. But within the last decade, scientific research has reversed the trend. The expanding chemical industries with their plastics and synthetic resins depend largely upon living things, and these are a product of the potentially inexhaustible resources of the soil. Long before the capital stored by Nature throughout geological time has been exhausted, man may well have learned how to live within his annual income.

History of Anglo-Czechoslovak Relations

UNDER the Czech title, "Sedm Set Let angločeských Vztahú", Dr. Kamil Kleiner has written for the benefit of Czechoslovak readers outside Nazi domination an account of the links between his nation and Britain. The earliest connexions were mainly exchanges between the theologians and educationists of the Universities of Oxford and Prague. With the development of the Bohemian University, founded by Charles IV in 1348, other learned men were attracted to Prague. Among them were Dr. John Dee, mathematician to Queen Elizabeth, and Edward Kelley, who visited Rudolf II in 1584 and stayed some years in Bohemia, which was then an important centre for alchemy and astrology. Dee eventually returned to England, but Kelley remained and after a chequered career died, according to Dr. Kleiner, in prison at Most in 1591.

After the time of Comenius's visit to England, 1641–42, there were few non-political contacts between Czechoslovakia and Britain until the nineteenth century, when English works were widely translated into Czech as a consequence of the national movement which began about 1790 with a revival of interest in the natural sciences and gained momentum in the early part of last century. The restoration of the Czech University in 1882 (it had been Germanized after 1620 when the Czechs lost their independence at the beginning of the Thirty Years' War) gave a further impetus to cultural relations with men of science and learning outside Bohemia. Czech students came to England, and British students and others, men of science among them, studied in Czechoslovakia, especially during the twenty years of independence. The disastrous developments of the last few years may still serve to strengthen the ties between Britain and Czechoslovakia.

Future of the Railway Oil Engine

ACCORDING to B. Reed, in a paper read before the North-East Coast Institution of Engineers and Shipbuilders, the most important factor influencing the whole future of any transport engine will be the fuel available. It will be absolutely necessary that the type of oil engine now used in road and rail transport shall be able to burn successfully fuels inferior to the present light Diesel oils. All development and applications will be governed very largely by this one factor, and the solution of the problem cannot be tackled too early. The spread of the War is increasing the difficulty of access to crude oil producing areas, and there is a question of whether the supply of fuels with a high cetane number will give out before the majority of high-speed engines have been adapted to burn successfully the lower grades of oil. Considerable technical progress has been made already in the burning of tar oils and vegetable oils, but the majority of engines are suitable only for the light Diesel fuels. The large slow-running locomotive type of engine certainly can burn heavy crude fuels without a great amount of trouble, but the far more numerous smaller high-speed engines for rail-cars and train sets need concentrated study, because it is essential they should be able to burn the poorer and heavier fuels without diminution in top rotational speed. The time available for ignition and combustion is one of the factors deciding the suitability or practicability of a fuel. Any standard engine of the future ought to be suitable for burning two or three different kinds of fuel, say, two heavy minerals and a vegetable oil, with the least possible modification.

Influx of Rare Winter Birds into Britain

THE recent severe winter, like that of 1939–40, has brought a considerable number of uncommon winter birds to various parts of the British Isles. In *The Times* of February 10, *et seq.*, Dr. D. A. Bannerman and others have reported most unusual numbers of rare waterfowl on the Thames at London, including pintail, gadwall, goosanders and hundreds of tufted duck, pochard, mallard and several shoveler, teal, shelduck, cormorants, coot, glaucous gull, great crested grebes, etc. The No. 2 (March) war-time number of *Country-Side* records the Iceland gull at Hammersmith; firecrests in Middlesex; eider and brent goose in Cheshire; barnacle geese, Bewick's swans, hen-harrier and hooded crows in Lancashire; siskins in Cumberland; smew, golden-eye and black-necked grebe at Tring (Herts); a flock of nineteen waxwings in Norfolk feeding on privet; great grey shrike and goosander in Surrey.

Later this winter the Merseyside Naturalists' Association has reported in Cheshire smews, goosanders and the red-necked grebe; smews, bittern, golden-eye and velvet scoter have been at the Ellesmere lakes, Shropshire, while an invasion of waxwings has included many flocks in the eastern half of the country, especially in Yorkshire (*Naturalist*, February), but they have extended their invasion to Dorset (*Country-Side*, March). In Wales there have been black redstarts on the Orme's Head and a flock of fifty siskins in alders in Glamorganshire. Earlier in the winter a flock of 5,000 widgeon was counted in the Ribble Estuary (Hardy, "Birds of the Liverpool Area", p. 167), but a grey lag goose that appeared at Regent's Park was believed to be a tame visitor from Kensington Gardens. Immense flights of knots have been off many river estuaries; flights of grey geese have been unusually numerous over many inland towns. The bulk of the winter visitors, especially the duck, came from Christmas onwards.

Birds of the Midlands

THE Ornithological Section of the Leicester Literary and Philosophical Society has issued a twelve-page county report and status of birds for

1941, as indicated when it was founded last summer, and as well as Leicestershire and Rutland, the report covers Nottinghamshire and Northamptonshire records of importance; 129 species are mentioned in the list, and some interesting visitors were recorded. The unusual influx of uncommon birds during the hard winter, noted from other parts of the country, is also borne out by the January and February 1942 bulletins, which report considerable numbers of gulls and sewage farm visitors. Altogether, the Society's record book has evidence of some two hundred species noted this century.

Principal Timbers of Jamaica

It is known that until within the last few years there was no forestry department in Jamaica and little information was available on the subject of the remaining forests. Some data have been collected on the chief native timbers and these are published by the Department of Science and Agriculture, Jamaica, in Bulletin No. 29 (New Series), "The Principle Timbers of Jamaica", by Mr. C. Swabey, conservator of forests (Kingston: Government Printers, 1941). Jamaica has a forest history common to many other Colonies of the British Empire. When Columbus first sighted the island it was covered in dense forests. Of these but little remains to-day; the fine mahogany, satin wood, sandal wood, lignum vitæ and other cabinet and dye woods which found their way to the markets of Europe are things of the past, the exports to-day being negligible. The chief reasons are shifting cultivation, failure to replant, felling of young and immature timber, barking of economically valuable trees and wasteful conversion.

The Forestry Department of Jamaica will have a heavy uphill task to face. Meanwhile a wise step has been taken in the issue of this small pamphlet. As the author remarks, it is unavoidably incomplete, but with the collection of further data a re-issue will become possible. In any event some of the chief forest types are here enumerated. A great obstacle to identification, met by no means for the first time in the British Empire, is the correlation of native names. "Not only are different names applied to the same tree in different districts, but the same name is applied to whole groups of trees and to entirely different trees in different districts." This is apparently particularly evident in the sweetwoods (Lauraceæ), the bulletwoods (Sapotaceæ) and the redwoods (Myrtaceæ). A considerable amount of botanical research will be necessary in some cases even to confirm some of the scientific names of certain trees.

Leaf-beetles Collected by Darwin

In the issue of the *Annals and Magazine of Natural History* of February, Mr. G. E. Bryant of the Imperial Institute of Entomology describes some Chrysomelidæ, or leaf-beetles, collected more than one hundred years ago by Charles Darwin. It appears that the specimens were found while rearranging and incorporating accessions to the collections of the family just named in the British Museum. Those obtained by Darwin were collected by him on the voyage of the *Beagle* during 1832–1836. They are very small, obscure insects belonging to the Halticinæ, or flea-beetle group, and were from South America and the Cape of Good Hope. They came to the British Museum through G. R. Waterhouse and by purchase at the sale of the collection of the Entomological Society of London in 1850. It may be mentioned that the British Museum received some 2,500 specimens from G. R. Waterhouse.

Vaccination in Napoleonic France

In a recent paper (*Bull. Hist. Med.*, 10, 635; 1941) Dr. Robert C. Dunbar remarks that the introduction into France of one of the most important scientific discoveries of modern times was delayed by war between France and Great Britain, and by the difficulties of preserving cow-pox virus. War, however, was much less totalitarian at the beginning of the nineteenth century than it is to-day, as is shown by the fact that Jenner, with the consent of an enemy Government, could enter enemy territory to introduce a new medical practice. The medical men of Geneva, especially Prof. Marie Auguste Pictet and Dr. Louis Odier, played a prominent part in the introduction of vaccination into France. The French medical profession in the Napoleonic era, though ready to receive new ideas, was at the same time very cautious, and refused to accept Jenner's discovery until its value had been confirmed by numerous tests in various parts of France, particularly Paris, Lyons, Rheims, Bordeaux and Metz. The new discovery was favourably regarded by the personnel of the Consulate and most of all by Talleyrand, while Napoleon himself had a high esteem for Jenner.

Epidemics in Haiti

According to Dr. Rulx Léon (*Bol. Of. San. Panamericana*, 21, 31; 1942), ex-Secretary of State in charge of the Public Health and Social Assistance Service, several severe epidemics of smallpox occurred in Haiti in early times, including those in 1518, 1738, 1740 and 1741. In 1518 treatment chiefly consisted in the patients bathing in a river. In 1825 when another outbreak occurred, the soldiers were vaccinated. It was not until 1920 that the people began to take vaccination and isolation seriously as means of controlling the disease. The first case of yellow fever, imported from Martinique, was reported in Haiti in 1691. Epidemics occurred afterwards in 1733, 1735, 1739, 1743, 1745 and 1746, and were followed by very severe outbreaks in 1798, 1802, 1803 and 1804. No further epidemics of yellow fever occurred in Haiti, but a few sporadic cases were reported from time to time, confined to the white colony. Epidemics of malaria and typhoid were also reported in Haiti in 1739, 1742, 1744 and 1766. The endemic diseases which often proved fatal in Haiti were mumps in 1740, measles in 1741 and 1889, rabies in dogs and humans in 1762, 1768 and 1782. An epidemic of influenza with pulmonary complications also occurred in 1852. Three years ago, Port-au-Prince had its second epidemic of diphtheria since 1892, and in 1935 anthrax made its first serious appearance since 1775.

Meteorology in Burma

The Government of Burma's official "Report on the Administration of the Meteorological Department, Burma, 1937–41" is the first—and until the situation in the Far East becomes very different will also be the last—report of a meteorological service that was formed as a consequence of the separation of Burma from India. In November 1936 the Government of Burma decided to set up this Service with the aid of Dr. C. W. B. Normand, director-general of observatories, India. Burma was already in possession of some observatories that had formed part of the India Meteorological Service, and according to the scheme worked out by Dr. Normand, these were to be maintained to form the backbone of the new service, while the former forecasting office at Rangoon, which was closed down as a measure of economy in 1932, would be reopened to form its headquarters. It was also arranged that at first the Meteorological Office at Calcutta would retain responsibility for the issue of storm warnings to ports on the coast of Burma. The Government of India gave further important help for the scheme by agreeing to the appointment for five years of Dr. S. C. Roy, one of the senior meteorologists of the India Meteorological Department, as the first director of the Burma service, and of Mr. S. S. Lal and Mr. S. K. Das as assistant directors for the same period.

Administrative control of the observatories of Burma began on April 1, 1937, and by July 1, 1937, all meteorological work in Burma, except gale warnings for shipping and the supply of hydrogen to pilot-balloon stations, was in the hands of the new service, which in the short period of its existence made good progress in developing its organization. Arrangements were made for daily pilot balloon ascents at the two airports, at Akyab and Mingaladon, from the beginning of 1939, and during the four years under review six new second-class observatories were begun. A workshop and laboratory for the repair of instruments were set up. The Government of Burma agreed to the acceptance by the director of membership of the International Meteorological Organization. Of all this activity there is probably no trace left; if the service is revived after the War it will presumably have to begin again at the very beginning.

Earthquakes registered in New South Wales

ACCORDING to the seismological bulletin of the Riverview College Observatory, recently received, sixty-four earthquakes were registered at the Observatory during July–September, 1941. These were divided as follows: eighteen in July, twenty-one in August and twenty-five in September. On August 2 a strong earthquake commenced recording with iP_{EZ} at 11h. 47m. 09s. U.T. from an estimated epicentral distance of 28·9°. The first pulse was condensational, and the maximum amplitude attained on the Galitzin seismometer was 67·5 mm. (magnification 311), at 57m. 18s. U.T. The shock finished recording at 15h. 30m. U.T., having lasted nearly 3h. 43m. Some of this spread would be caused by the difference in speeds of the various types of waves from the focus. On September 4 a strong earthquake commenced recording impulsively on all three components at 10h. 27m. 38s. U.T. from a probable epicentral distance of 3,100 km. (= 27·9°). The epicentre of the earthquake was estimated provisionally to be at lat. 7° S., long. 155·5° E. which is near Bougainville in the Solomon Islands. It attained a maximum absolute ground amplitude at Riverview of nearly 0·09 mm. at 10h. 36m. 27s. U.T. and finished recording at 14h. 20m. U.T., having lasted approximately 3h. 52·5m. On September 12, 1941, an earthquake of considerable severity commenced recording impulsively on all three components (NS, EW and vertical) at 07h. 09m. 15s. U.T. from a rather doubtful epicentral distance of 37°. Maximum amplitudes of 56·1 mm. (E with $V = 305$) were attained on the Galitzin records at 07h. 26m. 32s. U.T. and the earthquake finished recording at 09h. 25m. U.T., having lasted some 2h. 15·75m. The recording is strongly suspected of having come from a multiple shock. These three recordings appear to have been the greatest during the three months. Some of the lesser recordings have been somewhat interrupted by microseisms, which makes their interpretation difficult.

International Seismological Summary

THE International Seismological Summary, for July–September, 1934 has just been received. It was prepared at Oxford by, and under the supervision of, Miss E. F. Bellamy and sent to the press on September 17, 1941. In all, 183 epicentres and initial times of earthquakes were calculated from data supplied by observatories throughout the world. Of these epicentres 127 were repetitions from old epicentres and 56 were new. It is well known that lines of weakness in the earth tend to persist so that repetitions of earthquakes are relatively common. Eight of the earthquakes listed (with most of the instrumental data concerning them) were exceptionally well recorded while 83 were poorly recorded, probably because they were weak shocks. Only two of the shocks are suspected of having a depth of focus other than normal (presumably about 15 km. deep). The small number of abnormal shocks is thus outstanding. Of the two shocks concerned, one was on July 22 at 19h. 57m. 0s. U.T. with a depth of focus 0·025 of the earth's radius below normal and an epicentre at lat. 36·5° N., long. 70·5° E. which is in the Hindu Kush mountains to the north-east of Kabul; the other occurred on August 30 at 16h. 25m. 57s. U.T., had the same depth of focus, and an epicentre at lat. 19·3° N., long. 145·7° E., which is to the north end of the Challenger Deep in the Pacific Ocean. Both these areas have been the scene of moderately deep focus earthquakes in the past so that the occurrence is not surprising.

Seismic Surveying in New England

FROM *Earthquake Notes* of December, 1941, the new editor of which is Mr. A. K. Ludy, we learn that at least two groups have been conducting seismic surveys in New England during the past few years. The majority of studies have been concerned with the depth of glacial deposits over the underlying bedrock in an attempt to discover something more of the preglacial history of the area in question. The Lowell, Mass., quadrangle was thus studied by Dr. F. W. Lee and others. The Weston Seismic Unit has made similar studies about the area of Boston in studying the bed of the preglacial Charles and Mystic Rivers. The most recent survey by this unit was an under-water survey in the bed of the present Mystic River near Everett, Mass. Under-water equipment was loaned to Weston College by the Humble Oil and Refining Co., of Houston, Texas. Seismic surveys of the Triassic rocks of the Connecticut River Valley were made during the summer of 1941 by the Weston College Unit near Springfield, Mass. The depth to the base of the Triassic formations as well as preglacial topography were measured in several places near the Massachusetts - Connecticut State line. This study was made in co-operation with the Geological Society of America.

Public Address Systems

In a paper with this title, read recently before the Institution of Electrical Engineers, Mr. S. Hill, of Standard Telephones and Cables, Ltd., first outlines the classification of public address systems and then proceeds to a brief mention of the early history of the art. The basic elements, that is, the microphone, amplifier and loud speaker are next reviewed, an illustrated description being given of the double-button, moving-coil and cardioid types of microphone; typical polar characteristics are shown in the case of the latter type of instrument. Mention is made of the interrelation between public address technique and the art of architectural acoustics, and it is suggested that the architect should have some basic knowledge of acoustics and the advantages and assistance given by a public address system, or that he should co-operate with acoustic experts. It is, for example, extremely difficult for the public address engineer to install a system in a completed building when he is confronted with artistic as well as technical problems, loud speakers with large exponential horns being very difficult to reconcile with a decorative scheme.

The paper then deals with the general aspects of the planning and installation of sound systems, paying special attention to the problems associated with time interval and reverberation in auditoriums. Reference is made to the disturbing effect of noise, its cause and mitigation. Auditory perspective is discussed and compared with controlled reverberation, mention being made of the remarkable effects which can be achieved by either of these means. A description follows of some typical public address installations, special reference being made to those used for the religious pageant, "Le Vray Mistère de la Passion", performed in Paris in 1936 and 1937 and for the coronation of King George VI and Queen Elizabeth in Westminster Abbey in 1937, and to the system installed in the Argentine Chamber of Deputies in 1939–1940. The paper concludes with a cursory review of present-day trends, and the author remarks that in the present state of the art it is not possible, except in a few simple cases, to determine a unique solution of each problem.

Electrical Space-heating Methods

Mr. R. Grierson, in a noteworthy paper recently published (*J. Inst. Elec. Eng.*, 89, Pt. 2, No. 7; 1942), dealt with space-heating by means of electrically warmed floors, as applied to surface-type air-raid shelters, from the points of view of the thermal electricity supply and economic problems associated with the subject. The heat storage method advocated employs 'soil heating' cable suitably buried or placed in ducts below the floor surface. The investigation is described in considerable detail, and it has led the author to the following conclusions. No other form of space-heating provides an even approachable standard of thermal comfort for all the shelter occupants in return for the cost of energy used and space occupied. The method provides thermal storage sufficient to maintain the warmth-comfort standard when the electricity supply is interrupted during peak periods or by bomb damage to cables, substations, etc. It provides maximum safety against burns and shock due to inadvertent contact with the source of heat energy.

The space occupied by the installation is very small, as is also the risk of wilful damage. Maintenance, apart from cable failure, is nil. The initial cost of the installation is reasonable, and the total cost of operation compares most favourably with that of other forms of space-heating installations. The thermal capacity of buildings having 14-in. brick walls and 6-in. concrete floor and roof is such that it is technically impossible to provide any acceptable standard of thermal comfort for all the occupants, in response to the turn of a switch. The space-heater described requires no iron or steel, and the total labour per kw. capacity installed is probably the lowest for any form of heater. In view of its inherent characteristic of thermal storage at or about room temperature, it would appear that there is considerable scope for post-war development for certain classes of building.

Electrical Equipment for Farms

The Federal Security Agency and the U.S. Office of Education have recently issued a useful booklet (Vocational Division Bulletin No. 209) entitled "Building Electrical Equipment for the Farm", which is well worth study by farmers in Great Britain. The numerous uses for electricity on the farm and the widespread increase in rural electrification in the United States during recent years have turned the attention of farmers there to the building of electrical equipment. This publication is accordingly designed to provide teachers of vocational agriculture with reliable subject-matter organized in usable teaching form in order that they may be in a position to offer systematic instruction on building safe and simple electrical equipment for the farm. Its subject-matter has been supplied by the Rural Electrification Administration and other reliable sources, and it includes hints on farm wiring, maintenance and repair; analysis of operative training for the construction of special electrical devices or appliances peculiar to the farm; statements of certain interpretive science and related information in connexion with the various electrical applications; numerous line and half-tone illustrations; a list of the farm uses of electricity; a glossary of electrical terms; and finally, a list of references on electricity and the farm. Details are given for the construction of a poultry water heater, ultra-violet reflector for poultry, electric pig brooder, electric hotbed, electric stock-tank water heater, electric chick brooder and pen, exhaust fan room-cooling unit, and a combination electric room-cooling and garden-irrigating device. Advice is also given on the installation of a portable electric motor. Twelve important rules are given for the safe handling of electricity, and stress is placed on the inadvisability of amateur wiring, it being emphasized that this should be done by a competent wiring authority or electricity undertaking. This booklet should prove invaluable to progressive farmers working large tracts of land, where, because of the distances involved, contacts with skilled engineering labour are few.

Dry Cell Manufacture

In order to assist Indian manufacturers who have experienced difficulty in producing dry cells comparing favourably with those available in the Indian market, a systematic study of cell manufacture was undertaken in the laboratories of the Government Test House and the results are presented in Bulletin

No. 23 issued from the Office of the Director of Scientific and Industrial Research (Department of Commerce, Govt. of India). The report avoids highly academic discussions of the problems involved and concentrates chiefly on matters immediately concerned with the industrial aspects. Indian firms which had been importing most of the raw materials from Germany before the War (to the value of not less than ten lakhs of rupees a year) have now perforce to seek other foreign sources, and a survey of the indigenous materials was carried out with the view of replacing the foreign products used in cell manufacture. As a result of this, certain Indian manganese ores have been found capable of giving output results comparable with foreign ores of good quality.

The electrochemical theory of cells is briefly treated at the commencement of the Bulletin, which then proceeds to give an outline of cell manufacture. The materials and machines used receive a very comprehensive survey, as also do production methods and testing. The influence of various defects are examined in some detail, and a section is devoted to a consideration of the economic aspects of production. The Bulletin is mainly concerned with the bag type of cell, such of the packed type as are on the Indian market being of foreign origin.

Young Farmers' Club Booklets

THE latest addition to the excellent series of Young Farmers' Club Booklets is No. 9, "Garden and Farm Insects", by A. J. A. Woodcock. Others recently published are No. 2, "Bee Keeping", by R. Gamble, No. 6, "Grassland", by J. O. Thomas, and No. 8, "Goat Keeping". The price of each booklet is 6*d*. or they can be obtained from the National Federation of Young Farmers' Clubs, Oaklings, Canons Close, Radlett, Herts., post paid 9*d*. The booklets are most attractively set out, with first-class illustrations, and the subject-matter is presented in a form which is certain to stimulate interest. Technical terms are not avoided, but are introduced so naturally that they will be absorbed rather than consciously learnt. As introductions to the various subjects the booklets may be unhesitatingly recommended, and they will provide a sound background of information which will enable better use to be made of the more specialized leaflets issued by the Ministry of Agriculture.

Eugenics in India

THE first *Bulletin of the Indian Eugenics Society* (Calcutta, 1941) is an interesting paper of some twenty-four pages. The foreword describes the origin of the Indian Eugenics Society, the headquarters of which at present are in the Bose Research Institute. The aims and objects of eugenic researches in Bengal are described by Mr. S. S. Sarkar, the general secretary of the Society. A general introduction describing the hereditary disabilities occurring in Bengal, and including figures from various sources, is followed by a discussion of the possible methods of eugenic research. One fairly full pedigree from South Bengal is given, but a single pedigree of this nature cannot provide any conclusive information. Towards the end of the paper there is a list of hereditary anomalies, with what the author considers to be their modes of inheritance. The rules and regulations of the Indian Eugenics Society are given.

Population of Sweden

ACCORDING to preliminary figures (*Anglo-Swedish Rev.*, February) there was an increase last year in the number of inhabitants of practically all the towns in Sweden. The population of Stockholm increased by 10,462, bringing the total up to 605,575. In 1940 the number of inhabitants in the capital rose by 7,600 and in 1939 by about 13,600. The number of births in Stockholm is still increasing, being 3,061 at the end of 1941—the biggest for many years, as compared with 1,715 at the end of 1940. In 1939 the excess of births was about 1,500, in 1938 about 1,000, and in 1937 and 1936 only 56 and 45 respectively. For the years 1935 and 1934 there was even a deficit of births, namely, 361 and 491 respectively.

Merseyside Naturalists

AT the annual meeting of the Merseyside Naturalists' Association held in the Liverpool Royal Institution on February 8, Dr. J. C. P. Miller, of the University of Liverpool, was elected president; Mr. R. K. Perry, of Liverpool Museums, vice-president; Lieut. J. Bolton, chairman; Mr. Eric Hardy, secretary; and Mr. J. F. Stirling and Mr. G. K. Robinson, assistant secretaries. A new bird-ringing section was formed under the care of Mr. J. F. Stirling to extend migration studies. The Association's recently published "Handbook on the Birds of the Liverpool Area" (Buncle, Ltd., Arbroath), covering west Lancashire, west Cheshire and North Wales, has proved a success, despite the difficult times for scientific publications. Recording will be continued, and a future handbook on the fishes is contemplated.

Committee on Medical Schools

MR. E. BROWN, Minister of Health, in the House of Commons, on March 26, replying to Mr. Jewson on the question of the Government's post-war hospital policy in relation to teaching hospitals, said: "The Secretary of State for Scotland and I have decided to set up a committee, under the chairmanship of Mr. W. M. Goodenough, with the following terms of reference: 'Having regard to the statement made by the Minister of Health in the House of Commons on October 9, 1941, indicating the Government's post-war hospital policy, to inquire into the organization of Medical Schools, particularly in regard to facilities for clinical teaching and research, and to make recommendations.' The following have accepted invitations to serve on the committee: Prof. T. R. Elliott, Mr. A. M. H. Gray, Prof. J. Hendry, Prof. A. V. Hill, Sir Wilson Jameson, Prof. J. R. Learmonth, Sir Ernest Pooley, Sir John Stopford, and Miss Janet Vaughan."

Literature of Food Investigation

THE Index to the Literature of Food Investigation, issued by the Department of Scientific and Industrial Research, of which No. 2, Vol. 13, September 1941 has now appeared (London: H.M. Stationery Office. 4*s*. 6*d*.) is compiled by Agnes E. Glennie, assisted by Gwen Davies and Catherine Alexander. It is arranged in fifteen sections under such headings as meat, pig-flesh, poultry and game, fish, eggs, dairy produce, fats and oils, fruit and vegetables, grain products, crops and seeds, theory of canning, engineering, etc., each of which includes brief abstracts covering patent literature as well as periodicals. There is an author index, and the publication brings together references otherwise scattered through a wide range of abstract periodicals.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Linkage of Physico-Chemical Processes in Biological Systems

IN a previous communication[1] Prof. F. G. Donnan—to whose kindness I am much indebted—has developed further an idea arising out of work in this laboratory[2], concerning the cellular accumulation of potassium ions in association with an intracellular chemical reaction. In this process an external diffusible anion, after passing through the membrane into the cell, is converted into an indiffusible anion or anion complex (using the term 'indiffusible' with respect to the membrane). The case chosen by Prof. Donnan was the simplest, in order to illustrate the principles involved. An important biological limitation of this simplest system would be that equilibrium can occur in this case only with a pressure difference if the potassium is accumulated. On discussing this matter with Prof. Donnan, it seemed to us of interest to present the condition when this limitation disappears, and in terms of the symbols of his letter.

We need consider only the final equilibrium state, or :

$$\begin{array}{cc:cc} & Y^- & N^+ & \\ (I) & \Sigma A^- & \Sigma A^- & (II) \\ & K^+ & K^+ & \\ \multicolumn{4}{c}{M} \end{array}$$

in which (I) represents the interior of the cell, (II) the fluid environment, M the semipermeable membrane, K^+ the potassium ion, N^+ an indiffusible cation (which may be taken as sodium ion) and ΣA^- various diffusible anions, of which one type combines with an indiffusible neutral substance X within the cell to form the indiffusible anion complex Y^-. For simplicity, as before, in order to illustrate the ideas involved, the applicability of the laws of very dilute solution may be assumed, and also that the ions A^- and Y^- are univalent. We have then the following relations (where C denotes molar concentrations, and accented letters refer to II) :

$$C_K = \Sigma C_A + C_Y \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$C_K \Sigma C_A = C'_K \Sigma C'_A \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$C'_K + C'_N = \Sigma C'_A \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

from which :

$$2C_K = C_Y + \sqrt{C^2_Y + 4\,(C'_K)^2 + (C'_K C'_N)} \quad . \quad (4)$$

and

$$2\,\Sigma C_A = -C_Y + \sqrt{C^2_Y + 4\{(\Sigma C'_A)^2 - C'_N \Sigma C'_A\}} \quad (5)$$

whence $C_K > C'_K$ and $\Sigma C_A < \Sigma C'_A$, when C_Y and C'_N have real positive values. Equation (4) gives the quantitative expression for the accumulation of potassium ions in the cell against a gradient. Simple relations can be deduced for the special conditions when the hydrostatic pressures within and without are the same. Thus

$$\begin{aligned} P_{\mathrm{I}} - P_{\mathrm{II}} &= RT\,\{C_K + \Sigma C_A + C_Y - (C'_K + \Sigma C'_A + C'_N)\} \\ &= 2RT\,\{C_K - (C'_K + C'_N)\} \quad . \quad . \quad . \quad (6) \\ \text{or} \quad &= 2RT\,(\Sigma C_A + C_Y - \Sigma C'_A) \quad . \quad . \quad . \quad (7) \end{aligned}$$

whence, if $\mathrm{P_I} = \mathrm{P_{II}}$,

$$C_K = C'_K + C'_N \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$\text{and } \Sigma C_A = \Sigma C'_A - C_Y \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

These equations show that at equilibrium an *equality* of hydrostatic pressures could occur *together* with potassium 'accumulation' when *both* C'_N and C_Y, that is, the concentrations of the indiffusible cation without and the indiffusible anion within, have positive real values.

The membrane system so described is simpler than that existing between plasma and tissue cells, but indicates certain important relations which have been experimentally verified[2]. For C'_N we may read the sodium concentration of the plasma, and for Y^- a system similar to phosphate esters. The full membrane system for muscle has been treated elsewhere[2], as also the relations controlling the volume changes.

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[1] Donnan, F. G., NATURE, **148**, 723 (1941).

[2] Boyle, P. J., and Conway, E. J., *J. Physiol.*, **100**, 1 (1941).

The biological condition, referred to by Prof. Conway, means that he is considering the case of a cell where the semipermeable cell-membrane does not act like an *elastic envelope*, the distension of which, when the cell volume increases, produces an increase of hydrostatic pressure inside the cell, but like an *inelastic surface-layer*, the superficial area of which can vary with variation of the cell volume without affecting the internal hydrostatic pressure, the latter remaining sensibly equal to the hydrostatic pressure in the fluid environment. Prof. Conway has made this point quite clear in the investigation published in the *Journal of Physiology*, to which he refers. In this publication Prof. Conway has deduced a remarkable cell-volume relation, which he has experimentally verified in the much more complicated case of the muscle fibre - plasma equilibrium. I hope Prof. Conway will not consider it an intrusion if I indicate briefly how his reasoning can be easily applied to the simpler case considered in his communication (the symbolism and equations of which I shall use).

From the equations relating to electrical neutrality in (I) and (II), and the equation of membrane equilibrium, we have

$$C_K(C_K - C_Y) = C'_K(C'_K + C'_N).$$

Combining this result with Prof. Conway's equation $C_K = C'_K + C'_N$ (which results from the equality of hydrostatic pressures), we obtain at once

$$C_K = C'_K + C_Y.$$

Hence $C_Y = C'_N$. This means that the condition of equality of pressures *alone* gives the relation $C_K = C'_K + C'_N$, while this condition *plus* the three other conditions (electrical neutrality in both phases and the ionic membrane equilibrium) yields the relation $C_K = C'_K + C_Y$. Thus we cannot have equilibrium with *both* these two relations unless the (internal) C_Y equals the (external) C'_N. Now C_Y may be put equal to $[X]/V$, where V is the cell volume, and $[X]$ is the original mass of X in the cell (X denoting the neutral indiffusible substance inside the cell, from which Y^- is produced). From this it follows that C'_N *determines the cell volume*, when the experimental conditions are such that $[X]$ is sensibly constant.

In conclusion, I am much obliged to Prof. Conway for his elucidation of the biological condition, and wish to thank him for his very courteous reference to my humble effort.

The Athenæum, F. G. DONNAN.
London. March 12.

Dispersion of Cellulose Strands in Cell Walls

In the cell wall of plant fibres the submicroscopic cellulose strands are orientated in parallel. With some bast fibres they are orientated parallel to the cell axis (fibre texture), and with wood fibres or cotton hairs they follow the thread of a screw (spiral texture). In other cell walls the optical anisotropy suggests a dispersion of the cellulose strands as, for example, in sieve tubes and latex vessels (tube texture) or a complete random orientation as in certain parenchyma cells (folium texture)[1]. Such membranes must be built of a submicroscopic 'reticular texture' in opposition to the 'parallel texture' of the first-mentioned type.

From his research on conifer tracheids, the Valonia cell wall and the parenchyma of the Avena coleoptile, Preston[2] concludes that there exists only one type of submicroscopic cell wall texture, namely, the 'spiral texture', from which the fibre texture can be derived by steepening the pitch of the spiral. Therefore he takes only parallel textures into consideration, and the possibility of reticular textures with dispersed and ramified cellulose strands is not discussed: ". . . a change in the *dispersion* of a single direction . . . may only be accepted when other possible causes have been ruled out"[3]. His argument is as follows: The cell walls investigated show oblique extinction under the polarizing microscope. The extinction angle is said to represent the pitch of parallelized cellulose strands forming a spiral texture. This conclusion does not hold good, because the statement of oblique extinction proves only an oblique direction of the anisotropy, but by no means that the cellulose strands are parallelized. They may just as well be dispersed symmetrically to the observed extinction direction, which would be the statistical result of variously inclined cellulose strands.

Whether there is dispersion or not can be determined by the X-ray method or—as the X-ray analysis of single cell walls of isolated cells is impossible at the time being—by the tedious way of measuring the refractive indexes of the cell wall quantitatively. If all wall substances except cellulose are removed, we must expect the indexes of crystallized cellulose parallel and perpendicular to the observed pitch of the spiral[4]. But if there is dispersion those indexes have to be found between the major and the minor index of crystallized cellulose[5].

Fortunately there is a third, much simpler, way to prove the existence of scattered cellulose strands in membranes where dispersion occurs. After staining cell walls with chlorozinc-iodine a remarkable dichroism is observed in the polarizing microscope: in membranes with parallel textures the light is almost completely absorbed if the direction of the submicroscopic cellulose strands is parallel to the vibration plane of the polarizer, whereas no absorption at all is observed if the direction of the strands lies perpendicular to the vibration plane[6]. Therefore, it is only permissible to attribute a submicroscopic parallel structure to a single cell wall, if it gives the iodine dichroism black-colourless when turning the stage of the polarizing microscope. If, however, the membrane examined shows a measurable light absorption in both its extinction positions, the existence of a dispersion of the submicroscopic cellulose strands is established. In this way it can be proved whether there is a reticular texture in the cell wall examined. The angle of dispersion can even be calculated, if the absorption in the two main directions of anisotropy is measured. It is found that

$$\frac{D_{/\!/}}{D_{\perp}} = \frac{1 - \cos \alpha}{\sin \alpha}$$

where $D_{/\!/}$ is the optical density of the stained cell wall parallel and $D_{\perp}$ perpendicular to the cell axis (in case of parallel extinction), and α the angle of dispersion. By this method it is shown that the cellulose strands in the cell wall of latex vessels of *Euphorbia splendens* include angles of inclination from 0° to about 60° with the direction perpendicular to the vessel axis. The conception of a submicroscopic reticular texture is, therefore, valid for the cell wall examined.

A. Frey-Wyssling.

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Swiss Federal Institute of Technology,
Zurich. Feb. 24.

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[1] Frey-Wyssling, A., *Z. wiss. Mikr.*, **47**, 1 (1930); Proc. 6th Internat. Botan. Cong. Amsterdam, **2**, 294 (1935); *Protoplasma*, **25**, 261 (1936); **35**, 527 (1941); *Kolloid Z.*, **85**, 148 (1938); *Science Progress*, **34**, 249 (1939).

[2] Preston, R. D., *Phil. Trans. Roy. Soc.*, B, **224**, 131 (1934); *Proc. Roy. Soc.*, B, **122**, 76 (1937); **125**, 375 (1938); *Biol. Rev.*, **14**, 281 (1939).

[3] Preston, R. D., *Ann. Bot.*, **3**, 525 (1939).

[4] Frey-Wyssling, A., *Kolloid Beihefte*, **40**, 40 (1926).

[5] Preston, J. M., "Modern Textile Microscopy", p. 260, London (1933).

[6] Frey-Wyssling, A., *Jahrb. wiss. Bot.*, **67**, 597 (1927).

Ground and Polished Prehistoric Artefacts from Ceylon

Until recently it was the accepted view that Ceylon lacked prehistoric artefacts with signs of grinding or polishing. The Island does possess them, and an interesting collection of large specimens so treated was obtained in association with ground bone artefacts and the common pygmy implements. The large artefacts lay at the surface and down to a depth of 30 cm. in the caves 'Udupiyan galge, lat. 6° 45′ N., long. 80° 20′ E., and Batadomba lena, lat. 6° 40′ N., long. 80° 23′ E., the smaller ones persisting to a depth of about six feet. Dealing solely with the larger, thirty-four were celts and hammer stones fashioned from pebbles and bore drill holes, twelve were slabs of untrimmed stone, generally pitted on both surfaces, possibly 'anvils' employed in making burins, some were grindstones, mortars and pestles (Fig. 1). Several were stained with hæmatite. All were made from the less durable rocks such as amphibolite, granulite, gneiss, basic igneous rock and their combinations with biotite and garnet. They displayed heavy patination, while chert pygmies found alongside were only feebly patinated and quartz ones were almost unaffected; this speedier disintegration explains why the larger artefacts of Ceylon remained unknown[1] until 1940.

In many pebble artefacts the stone worker, after drilling a hole on one surface, had attempted to obtain another in the same place on the opposite side. The presence of several pits on this side suggests that he did not always succeed at the first attempt (Fig. 1; 1, 2). As the ends of these artefacts are battered, they are apparently celts with pits drilled for hafting or gripping.

The 34 celts (Fig. 1; 1, 2) ranged in length from 73 mm. to 127 mm., the grindstone (3) was 114 mm. long, the mortar (4) was 155 mm. by 140 mm., the 12 anvils were 230–80 mm. long and 165–200 mm. broad (5).

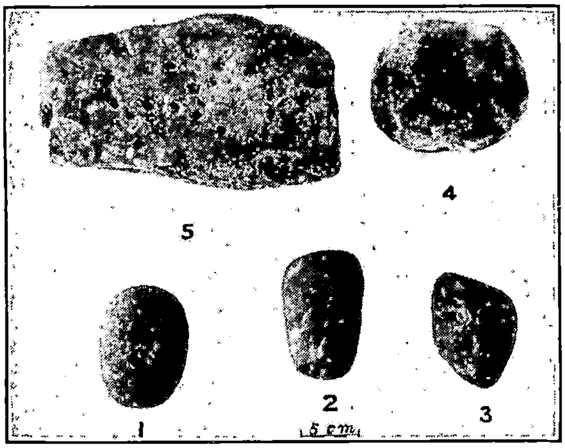

Fig. 1.
Large artefacts from Batadomba lena.

Bone artefacts comprising single points, rhombic forms with the narrower ends ground into conical points, and unmodified natural structures such as the toothed mandibular of the python (Fig. 2, *y*) and the spur-bearing tarso-metatarsal of the jungle fowl *Gallus lafayetti* Less. (Fig. 2, *z*) were apparently employed as piercing inplements.

In association with the artefacts were remains of animals of other existing species, such as swamp snails and bivalves, tree snails, crabs, mahsier, reptiles and mammals, as well as shells of the nut *Canarium zeylanicum* Bl.

The age of these artefacts needs consideration. There are two prehistoric culture phases in Ceylon[1]: (*a*) the *Ratnapura phase*, existing in association with fossils of hippopotamus and other extinct animals, and generally occurring at 12–40 ft. below the surface; (*b*) the *Balangoda phase*, occurring with remains of existing species and extending from the surface to a depth of about 6 ft.

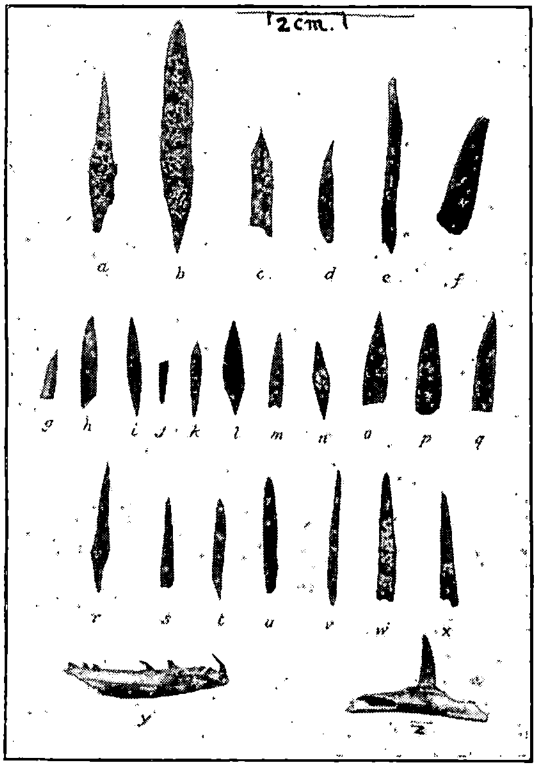

Fig. 2.
Bone artefacts from Batadomba lena.

The position of the larger artefacts here described, and the animal remains, suggest that they belong to the upper level of the Balangoda phase. The conical bottoms of the pits are characteristic of neolithic drilling, while the relatively fresh condition of some of the animal remains, and the survival of the Canarium nut shells, suggest that this culture phase survived until a comparatively recent date. The resemblance of the pitted pebbles to those from British lake deposits[2] and also to others from Bellary near Madras[3], when considered with the abundance of remains of swamp animals, is of interest. The artefacts cannot be ascribed to the so-called Väddhas, for these possess no tradition of the use of stone weapons, and further, regard the jungle fowl as taboo[4]. There is, however, the Väddha tradition of an extinct, hirsute, stone-using race of pygmies, the Äyo, who once competed with them[5].

The pygmy artefacts of Ceylon have been regarded by some as the work of a pygmy race, but the large size of the artefacts now discovered in association with such pygmy implements supports the view that their makers were not of abnormal size.

A detailed description will appear in *Spolia Zeylanica*, the journal of the Colombo Museum.

P. Deraniyagala.
Colombo Museum. (Director).
Jan. 23.

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[1] Deraniyagala, P., "The Stone Age and Cave Men of Ceylon", *J. Roy. Asiatic Soc.* (Ceylon Br.), **34**, 92 (1940); see also Nature, **147**, 392 (1941).

[2] Evans, J., "The Ancient Stone Implements, Weapons and Ornaments of Great Britain", Figs. 160–165 (1896).

[3] Dalton, O. M., Stone Age Guide, British Museum, 194 (1926).

[4] Seligmann, C. et B., "The Veddhas" (1911).

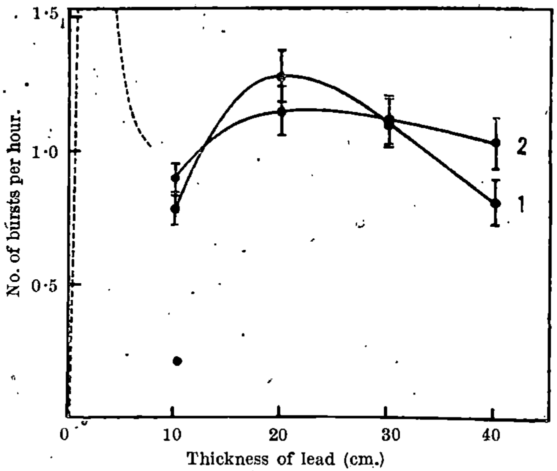
[5] Lewis, F., *J. Roy. Asiatic Soc.* (Ceylon Br.), **23**, 288 (1914).

The Second Maximum in the Rossi Curve

It is well known that the rate of production of cosmic ray showers by layers of any material increases to a maximum as the thickness of the layer increases, and then falls off very slowly for much greater thicknesses, giving the familiar 'Rossi curve'. Certain observers[1] have investigated the rate of production of showers under large thicknesses of iron and lead with coincidence counters, and have claimed the existence of a second maximum in the curve, while more recently Swann and Ramsey[2] have found the effect with tin. Other observers[1], however, have not been able to confirm the presence of a second peak.

Using an ionization chamber to detect and measure cosmic ray bursts produced under large thicknesses of lead, we have obtained evidence for the existence of the second maximum in the Rossi curve, and found a possible explanation of the failure of some observers to find the maximum with coincidence counters.

Our apparatus consisted of a steel-walled ionization chamber of wall thickness 3 mm. enclosing two coaxial cylindrical wire grids of length 58 cm. and radius 11·1 cm. and 2·5 cm. respectively as electrodes, and containing air at a pressure of 8 atmospheres. The collecting electrode was connected to the grid of an electrometer valve set up in a balancing circuit, and changes in the plate current of the valve caused movement of the mirror of a Moll galvanometer of period 0·3 sec., this deflection being recorded photographically on a rotating drum. Bursts were recorded with thicknesses of 10, 20, 30 and 40 cm. of lead above the chamber, the sides of which were throughout surrounded with 10 cm. of lead to prevent showers from the walls and ceiling of the room from reaching the chamber. The chamber was placed with its axis of symmetry vertical, and calculations showed that the passage of about twelve ionizing rays through the chamber from a point above it would, on the average, produce a sudden displacement of 0·5 mm. in the trace on the film. We have reasons, however, for suspecting that many of the shower particles which originate in the lead above the chamber and strike the lead walls around the chamber—which is long in comparison with its radius—are scattered back into the chamber, possibly accompanied by secondary rays, with the result that a kick of 0·5 mm. may correspond to a burst of a very few rays, possibly as few as three or four. Our results, however, do not rest on this assumption.



The accompanying diagram shows the rate of production of bursts, corresponding to kicks of between 0·4 and 0·6 mm. (Curve 1), and that for kicks greater than 0·6 mm. (Curve 2). The limits of error indicated for each experimental value on the diagram refer to the standard deviation. The general form of the Rossi curve for thicknesses of lead less than 10 cm. is indicated for purposes of comparison (broken curve). It will be seen that the curve for the smallest bursts has a very pronounced maximum at about 20 cm., a value agreeing within the limits of experimental error with those obtained by the observers who have obtained a noticeable maximum with the use of counters. The curve for the larger bursts is, on the other hand, nearly flat.

This suggests that the failure of some observers to obtain the second maximum with counters is due to the fact that the probability of detection of a shower with most counting systems increases with the number of ionizing rays in the shower, so that with some arrangements of counters and for large thicknesses many of the observed coincidences would be due to many-particle showers. This would tend to result in a curve which was fairly flat like Curve 2. The suggestion seems to be supported by the results of Swann and Ramsey[2], who used an elaborate system comprising a large number of counters capable of recording only double coincidences, and who obtained with tin a definite broad maximum as marked as that of Curve 1. Schmeiser and Bothe[3] found that their curves for iron and lead showed a less pronounced second maximum when the lower two counters of their triple-coincidence system were farther apart. They therefore attributed their peak to small-angle 'hard showers', but the assumption of small angles between the shower particles seems unnecessary. We suggest that separating their lower two counters favoured the detection of the larger showers to a greater extent, so that the curve then obtained was more like Curve 2 than Curve 1.

We have obtained preliminary results for iron which already indicate that the same effects occur as with lead, though at greater thicknesses, as would be expected. Full details of this work will be published elsewhere in due course.

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University of Cape Town.
Feb. 2.

C. B. O. MOHR.
G. H. STAFFORD.

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[1] *vide* Froman, D. K., and Stearns, J. C., *Rev. Mod. Phys.*, **10**, 133 (1938).

[2] Swann, W. F. G., and Ramsey, W. E., *Phys. Rev.*, **58**, 477 (1940).

[3] Schmeiser, K., and Bothe, W., *Ann. Phys.*, **32**, 161 (1938).

Geologists in War-time

I HAVE read with interest Prof. H. H. Read's account (NATURE, Jan. 10, p. 39) and the leading article in NATURE of March 14 on the lack of use of geologists in the present emergency, and can fully support the criticisms advanced. Included under the general designation 'geologist', however, are a number of other highly trained specialists the neglect of whom is not mentioned in these articles, but who are equally at a loss in their attempts to use their specialized knowledge to increase the war effort.

Every university department of geology includes on its staff, or on that of an associated department, petrologists and mineralogists, who must accept the decision that their first contribution is to continue the training of science students. Even where a reduction of staff leaves little time free from teaching duties during term, this pressure of work relaxes during the necessary vacations. The "fundamental dependence of industry upon mineral products", stressed by Prof. Read, does not end, however, when the raw material has been located, won and transported to the factory. In the chemical (including explosive) industry, the abrasive, refractory, ceramic and metallurgical industries, for example, process control and associated research must continue throughout manufacture and can most easily be achieved by the use of the chemical, optical and X-ray methods in which the petrographer, mineralogist and crystallographer are skilled.

Early in 1939 I played a small part in drawing up for the appropriate authority (on multipage documents each prepared in quadruplicate) a scheme for the utilization of the equipment, resources and staff of a particular laboratory; from that time three years ago the few problems which have reached that laboratory have done so through unofficial and accidental personal contacts. For the rest, the resources of the laboratory remain unutilized, the teaching staff chafe under a sense of complete frustration, while my carefully prepared quadruplicates doubtless languish untouched in some remote pigeon-hole.

F. COLES PHILLIPS.

Corpus Christi College,
Cambridge.

MICROBIOLOGY OF THE ATMOSPHERE

ONE of the symposia held during the fiftieth anniversary celebrations of the University of Chicago last September dealt with the function of air currents, temperature and barometric pressure in disseminating insects, bacteria and such plant diseases as rust. Scientific workers participating in the programme on aerobiology of the American Association for the Advancement of Science, in co-operation with the Committee on Aerobiology of the National Research Council, took part.

According to investigations reported by Claude E. ZoBell, of the Scripps Institution of Oceanography, University of California, bacteria are less abundant in marine air, rain and snow than they are in air masses of continental origin. The ratio of bacteria over oceans as compared to those over land may be approximately 1 to 250. A particle the size of a bacterium would be carried nearly three thousand miles by a steady wind having a velocity of ten miles an hour before it would fall to earth from a height of 100 ft. Though many bacteria in the air are killed almost immediately by sunlight, desiccation and other adverse conditions, marine bacteria are known to survive suspended in the atmosphere for several hours. Terrestrial bacteria found over the ocean hundreds of miles from land necessarily must have been in the air for as long as a few weeks, Dr. ZoBell added.

J. J. Christensen, professor of plant pathology at the University of Minnesota, pointed out that plant spores, such as rust, produced in astronomical numbers, are carried over wide areas by the wind, making control of plant disease difficult. Corn smut, ne of the most prolific of plant parasites, can produce gall twenty to forty cubic inches in size on a corn plant in less than two weeks, and each cubic inch ontains about six thousand million spores. A single acre of corn with 10 per cent infection may produce 0 trillion spores. Spores have been found as high as three miles in the air, and high winds, gales, cyclones carry enormous numbers of these pathogens to considerable heights. Because they fall slowly—corn smut spore falls only one hundred feet in four and half hours—the spores can be carried thousands f miles by air currents to infect crops.

Spores of black stem rust do not survive the hot, ry summers of Tunis, but the crop is infected each ear, probably by spores blown across the Mediterranean from Sicily and Sardinia. Australian dust has been deposited in New Zealand. Spores of leaf nd stem rust of wheat are regularly introduced into Manitoba by the wind. Excessive rains and such arriers as mountains, large bodies of water and desert constitute real barriers to the passage of the pores and other micro-organisms.

Computations made for all seasons of the year as o the number of insects in a column of air one mile square, starting at 50 ft. above the earth's surface, and extending to 14,000 ft., indicate, according to erry A. Glick, of the Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture, an approximate average of 25 million insects. The density of the insects decreases with height. In the day-time, at 200 ft., there are about one half the number found at 20 ft.; at 1,000 ft. there are more han one third the number found at 200 ft.; at 000 ft. there are roughly half as many as are collected at 1,000 ft. At times, however, there are wide deviations from the average, as when the mayflies appear or termites are on their dispersal flights. Some species of insects are much more abundant at night than during the day.

Temperature probably has the greatest effect of any meteorological agent on the distribution of insects in the air. The most favourable temperature for insect activity ranges between 75° and 80° F., Dr. Glick said. Dew-point also is an important factor, the most favourable figure for insect activity being a dew-point of about 62°.

At times of approaching storms when the barometer is falling, Dr. Glick said that insects become nervously active. It has been found that the migrations of the sugar beet webworm in Russia is connected with cyclonic depressions. When the air is calm, the insects are not disturbed and relatively few are found in the air. Many insects will cling tenaciously to vegetation when the wind is too great for safe flight. More insects are collected at low altitudes when the surface wind velocity is about five to six miles an hour, but at altitudes from one thousand to two thousand feet a wind velocity of seven to eight miles is more conducive to large numbers.

Although the direction of winds is an important factor in the distribution of insects, such as the migration of the pink bollworm from Mexico to the United States, many insects fly across the wind, or against it. The height to which insects may go is related to their size, weight and buoyancy. Insects with large wing expanse relative to size and weight are found at great heights. Many wingless insects are wind-distributed. Spiders often are numerous in the air, being carried by their silken threads.

Not only the winds but also aeroplanes serve as important distributors for insects, Dr. Glick said. One investigator has found 191 kinds of live insects on aeroplanes arriving in the United States from Mexico and Central and South America.

Insects may be an important factor in allergy, for investigations have shown that insect particles in the air may be greater than all the pollen: butterfly and moth scales in particular may be an important cause of asthma in the United States.

A STUDY IN PLANT ONTOGENY

I. H. BURKILL has recently published (*J. Bot.*; August, 1941) a very stimulating morphological analysis of ontogeny in a pure line of *Ranunculus arvensis*. It is of interest to see the new light thus thrown upon general trends of development, and such studies would form a valuable basis for further developmental studies of an anatomical or physiological nature.

Mr. Burkill notes that the shoot apex, after bearing the two cotyledons, continues to develop primordia according to a regular 2/5 phyllotaxis system which is maintained in the floral axes. The primordia of vegetative and floral parts are initially all alike, distinguishable only during subsequent development, and it is concluded that the nature of their development is determined by the axis. The poorer the nutrition the fewer leaves precede the flower—6, including the cotyledons, in starved plants as against an average of 9 in the spring-sown crop.

The leaves show progressive dissection up the vegetative shoot and the concept is introduced of "foci of arrest", which make their effect felt progressively earlier, so that, while the first leaves are merely toothed, the later ones are deeply lobed and finally the lamina may be regarded as compound with each main segment carried by a petiolule. This analysis of leaf form succeeds in conveying a vivid and contrasting picture of the progressive complexity of the leaf as compared with the alternative view which stresses the greater laminar growth immediately around each diverging vein.

Leaf asymmetry is very constant in character, the up-spiral (anodic) side of the leaf showing evidence of earlier development of the foci of arrest. Some primordia show signs of transition from foliage leaf to sepal or from petal to stamen and in these two cases respectively the down-spiral (cathodic) side is more vegetative or petaloid.

After its gradual increase in size and complexity, leaf size falls off towards the flower, but size and degree of complexity do not run parallel, so that the first reduced leaves are smaller replicas of the complex vegetative leaves, suggesting that more than one trend is operative in leaf development. Leaf shape also shows a progressive change in general outline from obovate to ovate, this change persisting well up beyond the region of larger leaves.

The lower a branch arises on the axis, the more leaves it bears before flowering, so that on both main and lateral axes the same number of leaves tends to supervene between root and flower.

When the apex of the main axis produces a flower, this is followed in sequence by flower development upon the highest branch and so progressively down the plant, so that "flowering radiates from the upper pole of the plant". Branching, however, is stimulated by vegetative growth from below while the upper pole functions by checking growth (when apical growth passes into carpel development), whereupon the vegetative effort is directed into other buds.

The author has since communicated to the *Proceedings of the Linnean Society*, November, 1941, the results of a statistical study of meristic variation in the flowers of the same species. This has led him to suggestions as to the influences (possibly hormonic) at work in the production of cyclic whorls. Isomery is traced to the uniform dispersion of such influences, possibly along main lines of contact, the parastichies, while variations in length of plastochrone are then thought to separate the various whorls.

FITNESS FOR MILITARY SERVICE IN THE UNITED STATES

LEONARD G. ROWNTREE, chief of the U.S. Medical Division, Selective Service, explained the function of this Service and described some of the results at a meeting of the American Philosophical Society on November 21–22.

Selective Service is charged with the procurement of men for the U.S. Army; more than 17,000,000 men had been registered and more than 2,000,000 examined, at the time the paper was read.

The Selective Service and Army boards have rejected as unfit for military service approximately 50 per cent of the registrants examined. About 100,000 were rejected for illiteracy; 430,000 were totally unfit for military service, and 470,000 were classified as *I-B*; that is, they might be fit for limited military service were they acceptable under Army standards.

These figures are not to be interpreted as representing 50 per cent invalidism of the registrants examined, or as indicative of 50 per cent illness o the population in general. They simply represent unfitness for military service according to the standard requirements that have been set up by the Army.

These cases of rejections are as follows:

Cause.	No. of cases.	Percentage
Dental defects	188,000	20·9
Defective eyes	123,000	13·7
Cardiovascular-diseases	96,000	10·6
Musculo-skeletal defects	61,000	6·8
Venereal diseases	57,000	6·3
Mental and nervous diseases	57,000	6·3
Hernia	56,000	6·2
Defects of ears	41,000	4·6
Defects of feet	36,000	4·0
Defective lungs, including tuberculosis...	26,000	2·9
Miscellaneous	159,000	17·7
	900,000	100

Because of the relatively poor physical state of 5 per cent of the registrants examined and the urgen need for man-power for national defence, Presiden Roosevelt has suggested that as many as possible o those rejected be rehabilitated. It is estimated tha about 200,000 have remediable defects. This work of rehabilitation has been assigned to the Selectiv Service System. Plans have been formulated, an the work is already under way.

AUSTRALIAN WIND TUNNEL

THE Australian Council for Scientific and In dustrial Research has just completed th installation of a wind tunnel at the Laboratory o its Division of Aeronautics. The tunnel is of th closed jet, single return type, the working sectio being an irregular octagon 9 ft. wide by 7 ft. high.

The shell of the tunnel duct is constructed of $\frac{1}{4}$-in steel plate suitably stiffened, with the joints welded t preclude any tendency to leak, and ground flush t minimize surface roughness. The working section where the pressure is atmospheric, is made of woo to facilitate the erection of models. The cascades o turning vanes, placed at each corner to deflect th air, are also of welded steel, with adjustable trailin edge flaps. Sheet steel, wood and plastic rubbe were used to fair and fillet the cascades into the wall of the duct.

The 550-H.P. motor is mounted centrally in th return duct on seven radial supports, designed t remove rotation from the flow behind the six-blade 13-ft. diameter fan. Six of these radial straightene serve to lead cooling air into and out of the moto while the seventh carries the electric cables. A unusual feature is that the section of the duct carry ing the motor is separated from the rest of the tunne Air-tight joints are made between the flanges on eac side by inflated rubber tubes (actually cycle ty inner tubing).

The tunnel was designed both for research and f tests of aircraft designs, so that the design aimed the best compromise between high speed (that i large Reynolds number) and low turbulence. B avoiding expansion through the corner cascades, an reducing the expansion-rate in sections where chang of shape are occurring, a very efficient design has been achieved. This is indicated by the measured top speed of 300 ft. a second at 550 B.H.P., corresponding with an energy ratio of about 6·0. A honeycomb and settling length have been incorporated to ensure low turbulence.

Speed control of the motor is effected by the Ward-Leonard system, constancy of speed being aided by using a synchronous motor to drive the generator. Calibration tests show the velocity distribution to be within the desired tolerance of ±0·5 per cent of the mean, while there is a pleasing absence of organ notes, whistles or undue noise at any speed. Radiation from the steel shell prevents temperature rises of more than a few degrees during the normal time of a test run.

The balance is situated below the tunnel, and supports the model through three streamlined pylons which pass through the floor of the working section. It has been constructed to measure the lift, drag and pitching moment of the model, but provision is made to add linkages for measuring rolling moment, yawing moment and side force. The maximum forces for which the balance was designed are 1,000 lb. lift and 250 lb. drag. A high order of accuracy has been obtained by careful design and precise workmanship, and the accuracy obtained on calibration was about 1 part in 5,000.

A range of subsidiary equipment has been provided, including a 20 kw. frequency changer for driving small electric motors built into the aeroplane models to rotate the airscrews. Two such motors have been obtained from the United States; they are 3½-in. in diameter and 5 in. long and each develops 5 B.H.P. at 18,000 r.p.m.

The tunnel and balance were designed by the staff of the Council's Division of Aeronautics, and built in Melbourne by Messrs. Kelly & Lewis. The airscrew driving motor, and its Ward-Leonard control system, were supplied by the English Electric Company, and the fan was also made in England by the Airscrew Co.

GEOLOGY OF LIBYA

IN a lecture delivered before the Geological Society on February 25, K. S. Sandford[1] reviewed existing knowledge of the geology of Libya, his account being in the nature of a sequel to an earlier contribution[2] in which he dealt with the geology of northern Central Africa. The geology of Cyrenaica and Tripolitania is already fairly well known. The Fezzan and the central and southern deserts and oases have been visited by certain scientific missions the publications of which have only recently appeared.

The southern part of the region is dominated by three massifs, each of which extends into adjacent countries: 'Uweinat on the east, Tibesti on the south, and Ahaggar on the west. Each consists of Archæan and other Pre-Cambrian rocks flanked by Palæozoic sediments. Tertiary and later vulcanism has added to the interest of these massifs. Around 'Uweinat there are numerous plugs, craters and lavas; while the other two are crowned by great volcanoes, and rise to heights of about 10,000 ft. The three massifs are separated by sandstone plains which stretch far to the north, sloping very gently in that direction, the sandstones representing continental conditions which appear to have been widespread during later Palæozoic, Mesozoic and Cainozoic times from the French territory on the west, through central Libya, to southern Egypt and the northern Sudan. The sandstones of the plains in turn disappear beneath marine sediments, of Cretaceous and Tertiary age, which represent transgressions of the Tethys, the ancestral Mediterranean, from the neighbourhood of the Gulf of Sirte far to the south. Libya escaped the Tertiary mountain-building movements which formed the Atlas, but the Saharan platform was, nevertheless, warped, upheaved, and broken. The three massifs of the south probably owe much of their differential uplift to these movements. Late volcanic activity is not confined to these highlands, for in central Libya there are vast expanses of volcanic rocks of comparatively recent date.

The Palæozoic sediments, well seen on the flanks of Ahaggar, constitute a long record of marine transgressions from the west. Definitely Silurian beds follow sandstones of doubtful Lower Palæozoic age, and are succeeded by Devonian formations. A temporary retreat of the sea is marked by Carboniferous beds containing Lepidodendron. The final stages of the transgression are recorded by subsequent Carboniferous marine beds, the latest examples of which are interbedded with sandstones containing fossil wood. Marine Permian appears to be absent.

As the sea retreated during the Devonian and Carboniferous, the Palæozoic land of Egypt and the Sudan broadened westwards, and by Permian time Libya was probably elevated and subjected to denudation. Except near the coast of Tripolitania, the sea continued to be excluded from Libya during the Triassic and Jurassic periods. The first important marine transgression from the Tethys was during the Upper Cretaceous, when there may have been a north-and-south strait across northern Africa east of Ahaggar. The second great Tethys transgression carried a Lower Eocene sea southward from Sirte almost to the northern flanks of Tibesti. Middle and Upper Eocene marine beds were deposited over much the same area. In the neighbouring Egyptian marine area, where the Cretaceous is developed on a grand scale, the sea fell back considerably during the Middle and Upper Eocene, and through Oligocene and Miocene times the regression continued in Libya as well as Egypt. Miocene marine beds can be traced from the shores of the Gulf of Sirte through Cyrenaica into northern Egypt. Continental conditions, such as had prevailed since the late Palæozoic, with only occasional interruptions, over much of southern Libya, then extended over the whole territory.

[1] *Abstracts Proc. Geol. Soc.*, No. 1384, 34 (1942).

[2] *Quart. J. Geol. Soc.*, 91, 534 (1937).

MODERN SCIENCE AND MUSICAL THEORY

THE bearing of modern discoveries in acoustics on musical theory was discussed by Ll. S. Lloyd in a paper read before the Royal Society of Arts on March 4. While the tuning of musical instruments and mathematics have an association that goes back to Pythagoras, it was Helmholtz who first showed, just eighty years ago, that the scientific basis of musical theory must be found in the physiological and psychological sections of the theory of hearing. Modern acoustical research has completely vindicated, with ample experimental proof, a pronouncement which for Helmholtz was an expression of deep scientific insight. Pythagoras had put the question: "Why is consonance determined by the ratios of small whole numbers?" The tuning of strings formed the basis of the question. Overtones in a musical note had been detected by the human ear. Mersenne recorded four, as occurring at the octave, the twelfth, the fifteenth and the seventeenth of the prime. When it was discovered that a string could vibrate simultaneously, as a whole, two halves, three thirds, and so on, and that the periods of these vibrations fell into a harmonic series: $1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}$, and so on, corresponding to notes of the scale, the simple numerical relationships were regarded as explaining simple musical intervals. The insistence of Helmholtz that the basis of any scientific theory of music must be sought in the coöperation of ear and brain, aroused considerable opposition.

Helmholtz had made simple experiments with his siren to dispose of the idea that the energy or intensity of a vibration alone determines its loudness. If the energy of the vibrations was left constant, the tone of the siren was faint in the bass but painfully loud in the high treble. The work of Fletcher and Munson[1] has placed this result on a firm quantitative basis over a wide range of frequencies, so that it must now be recognized that loudness depends partly on intensity, partly on frequency, and partly on overtone structure.

The next idea to be given up is that pitch depends solely upon frequency. Fletcher[2] recorded the average judgments, by skilled observers, of the pitches of a series of pure tones produced over a wide range of frequencies with loudness-levels ranging from 40 phons to 100 phons. As a standard of comparison for fixing the pitch, he used a pure tone with a constant loudness-level of 40 phons. At about the middle range of frequencies the pitch may be flattened by a whole tone or more as the loudness is increased. At very high frequencies the pitch becomes sharper, not flatter, as the loudness is increased, but the changes are greatest at lower frequencies. When four harmonics were added to the pure tone, Fletcher obtained only about one fifth as much pitch-change. Pitch therefore is dependent partly on frequency, partly on intensity, and partly on overtone structure.

These facts add considerably to the complexity of interpretation of combinations of notes into chords. Furthermore, Fletcher has shown that if pure tones are sounded together, the pitch of the sound heard may be that of a pure tone below those generated. Musical chords are built not from pure tones but from notes each of which contains several harmonics. The simple numerical relationships got from dealing with pure tones are therefore inapplicable to combinations of musical notes.

Reference was made to the chromatic stroboscope designed by R. Young and manufactured in the United States by C. G. Conn, Ltd., Elkhart, Indiana. When the instrument was used to study the pitch relationships between the notes of well-tuned pianos, surprising divergencies from accuracy were observed. The ear is by no means so exacting about the intonation of the piano as some detailed discussions imply.

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[1] *J. Acoust. Soc. Amer.*, **5**, 82 (1933).

[2] *J. Acoust. Soc. Amer.*, **6**, 59 (1934).

FORTHCOMING EVENTS

Wednesday, April 8—Friday, April 10

Science Masters' Association (at Rugby School, Rugby).—Forty-first Annual Meeting.

Wednesday, April 8

Evening—Mr. P. H. B. Lyon: "English in the Science Course" (Presidential Address).

Thursday, April 9

Morning—Prof. M. L. E. Oliphant, F.R.S.: "Recent Practical Applications of Nuclear Physics".

Afternoon—Mr. L. J. F. Brimble: "Human Biology in Education". Annual General Meeting.

Evening—Prof. L. Hogben, F.R.S.: "Science and Citizenship".

Friday, April 10

Morning—Discussion on "Science in Post-War Education", to be opened by Mr. E. G. Savage.

Thursday, April 9—Monday, April 13

British Psychological Society (at the Municipal Training College, Brighton). Extended General Meeting.

Wednesday, April 8

Society of Chemical Industry (Food Group) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Dr. J. Hammond, F.R.S.: "Animal Production in the Post-War World".

Thursday, April 9

Physical Society (Joint Meeting with the Science Masters' Association) (at Rugby School Science Laboratories, Barby Road, Rugby), at 10.15 a.m.—Mr. C. W. Hansel: "Fundamental Laws and Definitions in Physics", 1: Ohm's Law; 2: Specific Heat and Newton's Laws of Cooling; 3: Mass. Mr. P. Woodland: "The Need for a Permanent Standardization and Guidance Committee for Elementary Physics".

Friday, April 10

Royal Society of Arts (India and Burma Section) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Diwan Bahadur S. E. Runganadhan: "The Work of Indian Universities".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting.

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. F. J. North: "The Centenary of the Glacial Theory in Britain; Notes on Contemporary Manuscripts and Publications".

Institution of Mechanical Engineers (at Storey's Gate, London, S.W.1), at 5.30 p.m.—Mr. H. E. Dance: "Mechanical Aids to War-time Training".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Horticultural Assistant to the Agricultural and Horticultural Organizer—The Clerk to the County Council, Shire Hall, Bedford (endorsed 'Horticultural Assistant') (April 11).

Lecturer in the Department of Mathematics—The Registrar, University College, Singleton Park, Swansea (April 22).

Assistant Master to teach Mathematics and Elementary Science in the Junior Technical School—The Secretary for Education, Tudor House, Friar Street, Worcester (April 25).

Student-Demonstrator in Botany—The Principal, Royal Holloway College (University of London), Englefield Green, Surrey (May 1).

University Chair of Oil Engineering and Refining (Petroleum Technology)—The Secretary, The University, Edmund Street, Birmingham 3 (May 9).

University Chair of Radiology (Therapeutic) tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (May 26).

Chief Metallurgical Chemist to take full charge of Steelworks Laboratories, for employment in the East—The Central Register, Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting Z446X).

Assistant Metallurgical Chemist to act as Principal Assistant to the Chief Chemist of a modern Iron and Steel Works—The Central Register, Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, S.W.1 (quoting Z447X).

CATALOGUES RECEIVED

Londex Synchronous Time Delay Relay, Type PRL, ranges 2 sec. to 28 days. (List No. 97.) Pp. 2. (London: Londex, Ltd.)

The Wild-Barfield Heat-Treatment Journal. Vol. 4, No. 30–31. Pp. 55–70. (Watford: Wild-Barfield Electric Furnaces, Ltd.)

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University College

ADULT EDUCATION AS A SOCIAL ACTIVITY

THE problems of man-power and woman-power to which attention has been directed by recent speeches of the Minister of Labour and National Service in view of the growing demands which the War is making upon our resources, have two main aspects, mobilization and utilization. The former is liable to receive more than its due share of attention, and the recent report of the Beveridge Committee on Skilled Men in the Services is a timely reminder that the reservoirs of labour, skilled or unskilled, male or female, are strictly limited. The mobilization of every available man or woman will be insufficient to develop our full fighting and productive powers unless there is wise apportionment of labour between the different fighting services, war production and the essential services, including civil defence, transport, and the like. Equally it will not be developed unless that disposition is made in conditions which call forth from each individual his or her maximum effort, and in which physical, mental and moral vigour can be sustained through whatever days of trial or endeavour lie ahead.

The question of morale is thus of supreme importance, and Mr. Bevin's remarks on management in his recent statement in the House of Commons may arouse misgivings as profound as any of the revelations in the Beveridge Committee's report. The responsibility of management in the maintenance of the conditions which promote industrial efficiency is so fundamental that the failure of the Minister to utilize the powers which he already possesses to deal drastically with inefficient management will recoil severely on his own head if not rectified. The co-operation between management or employer and the worker has two sides, but we cannot complain of lack of response on the part of the worker until the employer —and the Government—have done their utmost to establish the right conditions.

The prescience of Mr. Winant's words in his valedictory report to the International Labour Organisation last year has been attested by much that has happened in Great Britain and in the United States since they were written. The democracies cannot survive unless they achieve effective co-operation between Governments and organizations of employers and workers. Its absence is the primary and fundamental cause of waste of labour, whether in the neglect of personnel management, the failure to establish proper working conditions, to utilize the scientific knowledge acquired so painfully in the field of industrial health, or in the petty misunderstandings over income tax deductions and the like through indifference to psychology and the human element generally.

Mr. Bevin in his speech rightly referred to a great weakness in British industry due to the failure of employers to give the personnel management its proper status. Although over a very wide field of industry that mistake is now being rectified, we still suffer from the long neglect to extend the scientific study of the human side of industry. With adequate support in the past such bodies as the Industrial Health Research Board and the National Institute of Industrial Psychology could have been ready with a far wider range of experience for the solution of pressing problems. As it is, the reports of the Select Committee on National Expenditure, like the emergency reports of the Medical Research Council, bear melancholy witness to the failure to apply knowledge on hours of work and working conditions generally which were acquired a quarter of a century ago.

There are welcome signs that, in the Services as well as in industry, the scientific use of labour is being attempted on an increasing scale. The appointment of an advisory committee consisting of Dr. C. S. Myers, Prof. J. Drever, Prof. F. C. Bartlett and Prof. C. Burt to assist the Director of Personnel Selection shows that the Army recognizes the value of scientific knowledge in this connexion, and the annual report of the National Institute of Industrial Psychology affords other evidence of the utilization by the Services of scientific men in the training and selection of personnel. The scientific aspect, however, is only one side of the problem. Important as may be scientific selection and training of labour, the use of scientific knowledge to establish the best working conditions, to minimize hazards to health, to eliminate accidents and to reduce friction between management and workers, more is required if production is to reach its maximum efficiency.

Despite the emphasis placed on this subject by the Acting Director of the International Labour Office in his report to the International Labour Organisation Conference at New York last October, and the admirable report on War-time Developments in Government-Employer-Worker Collaboration prepared for consideration at the same Conference, neither in Great Britain nor in the United States can we be said to have reached the heart of the problem. Primarily it is one of education, and the main responsibility for initiative must inevitably lie on the Government. Moreover, it is a question of adult education; not merely of educating the adolescent entering industry for the first time, but rather of enabling the great mass of adult workers to understand what is required of them, to see their own part in relation to the task of the nation, and how their own zeal and efficiency and sacrifice can fortify the national effort and shorten the road to victory.

The vital importance of adult education in this matter has, generally, not been grasped. It completely transcends the scheme for joint consultative and advisory committees consisting of representatives of workers and managements already initiated for the Royal Ordnance Factories by the Director-General, Sir Charles McLaren. These committees are intended to smooth difficulties by arranging the regular exchange of views between management and workers on matters relating to improvement of production and increase of efficiency.

A constitution for Factory Production Committees was signed on February 26 by representatives of the Ministry of Supply and of all the trade unions having members in the Royal Ordnance factories. The functions of the committees are defined as "to consult and advise on matters relating to production and increased efficiency in order that maximum output may be obtained". Meetings will be held fortnightly or as required, but the workers' side is to meet weekly to expedite procedure. A central committee has been set up to ensure immediate and efficient application of the scheme and it will act as a pool for ideas.

This development is essentially an extension of the works council scheme which has been used by progressive firms for a number of years past. The important contribution it should undoubtedly make to efficiency and output should not lead us to overlook the fact that it scarcely touches the wider question of morale. One of the real weaknesses in morale in Great Britain is the lack of understanding and interchange of ideas between those who direct the War and those who are directed. Despite all the efforts of the Prime Minister himself and his great power of interpreting the situation and strategy of the War, this is notably true of industrial and civilian defence workers. Adult education is essentially related to morale in the waging by a democracy of total war.

While, however, the importance of education as a very corner-stone in reconstruction is widely appreciated, the importance of adult education in that respect, and still more in regard to the war effort, is almost completely overlooked or ignored. Adult education, it is true, receives passing mention in a pamphlet "Education for Democracy", by Barbara Drake, recently issued by the British Association for Labour Legislation (London: 1942. Pp. 44. 9*d*.); here the importance of developing systems of adult education as centres of social activity as well as seats of learning is recognized, as well as of encouraging voluntary bodies, organized on democratic lines, which provide suitable courses of adult education. The report referred to above on War-time Developments in Government-Employer-Worker Collaboration, however, does not even mention education.

The truth is that the War will be won and the peace made by the generation of men and women who are grown up now. Unless by adult education we attempt to correct mistakes in their outlook, training and vision, the growing generation may, like its predecessor, find its prospects once again shattered by failure of this grown generation to seize the opportunities opening now before it. Moreover, it should be remembered that the success of the war-time measures of co-operation between workers and employers and the Government is due primarily to the recognition of their validity and purposes both by the trade unions and by management. This recognition was largely due in turn to the need for expedition in settling grievances and to the special care taken to avoid arousing antagonisms by rigid enforcement. There must be some similar recognition and understanding by the mass of the people if they are to take their place in a new and better social order, and this it is a prime function of adult education to supply.

The contrast between the free nations and the totalitarian regimes is nowhere more marked than in this matter of the methods of democratic collaboration. The value of such collaboration in the formulation and application of a labour policy has been repeatedly demonstrated in dealing with the many problems involved in the allocation of man-power between industry and the Armed Forces, the control of employment, training and apprenticeship, dilution of skilled labour and transfer, and the mobilization of women and other labour reserves. As a recent P E P broadsheet on mobilizing woman-power indicates, it may well be a decisive factor in regard to the use of part-time labour. Tripartite collaboration, through its assistance in safeguarding the interests of workers in the factories, those mobilized for the army, and of seamen, both in the Mercantile Marine and in the Navy, has already made important contributions to the national morale, and has often made important contributions in such matters also as problems of safety, elimination of hazards, prevention of accidents from fatigue, overstrain and tension, and the promotion of industrial hygiene.

The full use of our national resources, whether in time of war or of peace, and the provision of the commodities and services necessary to raise or even maintain general standards of living, involve the full co-operation of employers and workers with the Government at every stage, from the initiation of a policy to its application and enforcement. The educational aspect of such collaboration is, however, often overlooked. National safety and efficiency make it essential, for example, that all groups in the community should understand the aims of certain measures—rationing restrictions, black-out precautions and fire prevention are typical examples. The part which organizations of employers and workers have played and must play in the interpretation of such measures and in carrying back into the local community understanding of the problems at issue and in furnishing explanations of policy is seldom appreciated.

Such educational work—education of the adult in a very practical sense—is one of the most important functions of the machinery of co-operation established during the War. Further, one of the most imperative needs at the present moment, if we are to attain and sustain our maximum productivity, is for a deliberate planned extension of adult education of this type. Without it the fresh sacrifices being demanded of us, the call to more spartan living and strenuous endeavour, may fail of their full effect and purpose through inadequate response, misunderstandings or avoidable friction. As already noted, the poor morale which at present exists in some sections of the people of Great Britain, particularly among industrial and in civil defence workers, is due largely to the lack of interchange of ideas and common principles of understanding between those who direct the War and those who are directed.

The maximum war-effort can only be obtained with the full co-operation of the consciousness of our society, and the lack of co-operative thinking, knowledge and discussion between the two sections of our democracy may be disastrous. We must have leaders who can explain to the members of the Services and the workers the longer-term geographical and historical implications of the War, the tasks before us, the dangers ahead, the principles and practical problems of the post-war era. Moreover, it is just as important that these leaders should listen to complaints as well as talk and interpret.

The recent debates in Parliament have shown how admirably the House of Commons is fulfilling the vital function of interpreting to the Government the mind of the nation. To meet the primary need, the suggestion recently advanced by Mr. Stephen Spender in *The Times* of February 25 of extending the idea of the education officer already found in the Army merits careful exploration. Mr. Spender suggests that there should also be education officers in factories, in civil defence and possibly in civilian life. Their task would be threefold: to assist the people to understand the tasks that face us as a people sharing common aims, principles and opportunities; to win conscious co-operation in the furthest aims of the War and the ensuing peace; and to equip the individual to be educated, socially responsible, and imbued with the principles of a less anarchic form of post-war society.

Whether or not some definite organization is required to implement this essential work of education, voluntary effort will still be required if only to fill the gap while some formal scheme is being elaborated. Without vision the people will indeed perish, and on all who have caught some glimpse of the values that are at stake, of science, of art, of religion, of any aspect of that tradition of humanism that has been handed down to us, or who have some understanding of the ultimate purposes for which we are fighting, lies the obligation to share it as widely as possible with their fellows. Scientific workers, many of whom recognized the challenge and threat to our heritage long before the outbreak of war, have a special as well as a general responsibility in this matter. With their responsibility for seeing that science makes its fullest contribution to the national effort, for waging relentless war on any source of technical or administrative inefficiency, lies this further responsibility of helping their fellow-workers, their comrades-in-arms and their fellow-citizens to share that vision of deep purpose and final victory, and, sharing it, to see the part which each must play in the furtherance of that purpose, the winning of that victory and the shaping of the nobler order in which that purpose will be achieved.

THE WAR-TIME SOCIAL SURVEY

A RECENT report of the Select Committee on National Expenditure provides a striking vindication of the War-time Social Survey of the Ministry of Information, which has been the subject of much adverse criticism. The appearance of the report is of special interest at the moment in view of the renewed attention being given to the organization of social research. The Committee is emphatic in its opinion that the War-time Social Survey is an essential service, performing useful work, and that on the whole the lessons of past experience have been learnt. The report administers a severe and well-deserved rebuke to the attack last summer on the Survey both in the Press and elsewhere, but also provides yet another warning of the way in which sectional interests or prejudices, sometimes inspired by Departments of State, are still able to impede or frustrate action or inquiry desirable in the general interest.

The Survey was established under the auspices of the National Institute of Economic and Social Research, in order to guarantee the scientific status of the personnel and methods used. A member of the professorial staff of the London School of Economics was appointed director, and there was also a committee of scientific advisers who were consulted both about the lines on which an inquiry should be conducted and about the scientific validity of all reports. The Survey was housed in a separate building from the Ministry of Information, the names and addresses of the persons interviewed are never passed on to the Ministry, and not one of the staff of the Survey was a Civil servant.

By June 1940 these arrangements were working well, and although since the autumn of 1940 the work has no longer been carried out under the auspices of the National Institute of Economic and Social Research, the advisory committee has been abolished and the staff has been reduced, the remaining safeguards having been retained. Reports were no longer circulated outside the Ministry of Information, and the Survey was used only for work commissioned by other Departments. As a result of further reorganization in the summer of 1941, the Survey now works under the general supervision of the head of the Home Intelligence Section of the Ministry of Information, under the control of the Director, Home Division. Its present constitution and activities were stated in NATURE of February 21, p. 214.

The Survey interviewers, who are all women, are selected with the greatest care, with particular emphasis on their intelligence, conscientiousness and trustworthiness. They are given careful training as well as exact coaching in the subject to be investigated, and the questionnaires are drawn up with the help of the advisory panel and the Department for which the inquiry is being made. The Ministry of Food and the Board of Trade are the Departments which have made most use of the Survey, the estimated expenditure for which for the current financial year is about £40,000.

The Select Committee is satisfied that the costs are not excessive and comments on the continuous use of the Survey, but it stresses the importance of laying down a carefully considered policy and planning the work. It emphasizes, secondly, the importance of great care in the choice of subjects to be investigated. The Survey should be used for factual inquiries which are necessary to guide a Ministry in some particular policy, and not for inquiries which attempt to assess morale. No inquiry should be begun without careful consideration as to its real necessity. The success or failure of an inquiry depends almost entirely on the interviewers, and no relaxation of the present standards should be entertained. Finally, and somewhat surprisingly and unconvincingly, the Committee recommends that the Survey should not be connected with or controlled by any one Department, but should accordingly be transferred from the Ministry of Information and placed under the direct authority of a member of the War Cabinet, for which purpose the Lord President of the Council is suggested, as being already responsible for scientific matters.

THE PROBLEM OF THE AUTONOMY OF LIFE

Science versus Materialism
By Prof. Reginald O. Kapp. Pp. vi+280. (London: Methuen and Co., Ltd., 1940.) 10*s.* 6*d.* net.

THE title of this book is rather misleading, since its main theme is an exposition of the author's 'philosophy' of vitalism, versus a scientific description of the phenomena of living organisms in terms of the existing concepts and laws of physics and chemistry. In this connexion he appears to be a 'materialist', that is, when he is contrasting the phenomena of life with what he calls the "material Universe", by which he seems to denote inanimate things. His great argument here is that living organisms cannot arise solely from the action of "matter on matter". He admits that the laws of physics and chemistry are operative in living organisms, but holds that they do not fully determine the "pattern" of life. This, according to him, is "doubly determined", that is, determined not only by the laws of physics and chemistry but also by "something else". This something else is "non-material".

Lest the ordinary reader might fall into the error of supposing that this "new light" amounts to a return to the Platonic doctrine of ideal forms, Prof. Kapp is careful to point out that the Platonic forms were applied by Plato to inanimate as well as animate things, whereas he (Prof. Kapp) intends his "immaterial something" to apply only to the "patterns" presented by living organisms. He does not refer to the Aristotelian entelechy, but no doubt that ancient ghost would suffer the same fate as the Platonic form, though Prof. Kapp's immaterial something looks very much like a confused mixture of the Aristotelian "final cause" and "formal cause". So what, according to the author, is his philosophic solution of the age-long problem of life? Being an engineer, he finds his mental haven of rest in one blessed word, "specification". The patterns of life unfold and repeat themselves according to some non-material, pre-determined and pre-conceived "specification". The molecules of matter, according to the author, do not *in this case* "shake down" into positions or states determined solely by their motions and intermolecular forces. No, no—there is always the "specification" to guide them to something better than that, just as the blue-prints of the engineer's drawing office direct the pattern maker, the foundry man, and the machine tool operator. Indeed, Prof. Kapp has no great objection to a living organism being regarded as a sort of machine, for "matter acting on matter could never produce a machine".

This oft-repeated argument against the possibility of living organisms arising from matter acting on matter rather reminds one of du Nouy's argument concerning the enormous improbability of a living organism arising out of a "material", that is, inanimate system in statistical equilibrium. Nobody with any knowledge of science would ever suppose such a thing. Both Prof. Kapp and Dr. du Nouy have forgotten the potency for producing order residing in the disequilibrium between the 'hot' radiation of the sun's photosphere and the relatively cool surface of this planet, though Schrödinger pointed out a number of years ago that no consideration of the problem of 'living organization' which left out of account the sun's enormous store of 'organized' energy could possess any scientific value. It may be pointed out to the author that the existence and activity of a living organism depend absolutely on the presence in its environment of certain chemical substances which are *not* in equilibrium, this disequilibrium (and consequent potency for producing order) being a direct consequence of the previously mentioned disequilibrium of radiation and matter. It is a curious and instructive fact that, in his yearnings for a "non-material entity", an electrical engineer should have failed to consider the part played by the electro-magnetic field and electro-magnetic radiation.

Prof. Kapp tilts at a number of people whom he calls "biologist-philosophers", among whom one may mention L. Hogben, J. Needham and J. B. S. Haldane. What he particularly dislikes about these biologists is that they *will* persist in the endeavour to describe the phenomena presented by living organisms in terms of the existing concepts and laws of physics and chemistry, that is, they do not invoke the aid of any metaphysical entity, whether entelechy or "specification". Now, Prof. Kapp admits that these biologist-philosophers are quite reasonably good, *qua* biologists. Where they err is in their lack of knowledge of the real nature of physico-chemical science! They might, however, retort that Prof. Kapp's knowledge of physico-chemical science is rather peculiar, to say the least of it, when he omits all consideration of one very pertinent *non-material* entity, to wit, radiant energy. But they possess a stronger argument even than that, namely, Prof. Kapp's "philosophy" of modern physico-chemical science, which is expounded in his discussion of "The Material Universe". Here one can detect the ominous effect of certain semi-popular expositions of modern physical science on the naïve mind of an engineer. Hearken, please, to the portentous words of warning with which the author introduces Section III (the *author's* version of the "Material Universe"): "if physicists were to describe what they find in Nature instead of what they have invented, they would sum up their observations in the words: Chaos, everywhere chaos". To this one can only say, "Eddington, O Eddington, behold what thou hast done!" Or should one blame the "Paycock"? For Prof. Kapp, the atoms and molecules represent no "repeated patterns", indeed no objective patterns at all, for they are the inventions of the minds of the physicist and chemists. His primary object in this section is, of course, to demolish the "objective reality" of what he calls the physicists' "material" world, so that he (Prof. Kapp) may be in a position to point out triumphantly to the wicked "biologist-philosophers" that they are trying to construct the "objective reality" of the living organism out of the stuff of pure thought. The elementary mistakes and logical fallacies of this section of the book are very obvious, and are strongly reminiscent of some of the 'popular science' of the Sunday Press.

It would, however, take too much space in a brief review to discuss in detail the author's fantastic views on *his* "Material Universe", or his subsequent demolition of the "philosophy of emergence". He gets fiercer and fiercer as he proceeds: *L'appetit vient en mangeant.* Enough has probably been said to give any potential reader an outline of the "new light" which the author seems to think he has shed on the question of "vitalism". In the opinion of the reviewer, however, he has made no contribution to philosophy or to science.

There does, indeed, exist a problem of the "autonomy of life", a problem which is at least as old as the writings and observations of Aristotle. This is really a part of the epistemological problem of the description of our knowledge. It is quite a wise and practical policy of the wicked "biologist-philosophers" to find how far they can go in describing the phenomena presented by living organisms by means of the existing *and rapidly developing* concepts, methods, and 'laws' of physics and chemistry. But, of course, this does not mean that fundamentally new *scientific* concepts and new logical methods of thought will not be necessary for the ultimate autonomous description of our knowledge of the phenomena of living things. The ancient concept of teleology, for example, with its implied concept of 'purpose', may perhaps be replaced in time by a sort of *teleochronism*, that is, actions at a distance in time, to be described by some new form of mathematics, or at least by integral and integro-differential equations and Volterra's theory of functionals, wherein the nuclei may be historical time-functions, descriptive of an internally determinate pattern of action. The discussions of Niels Bohr on the autonomy of the description of our knowledge of life, especially the application of his principle of "Complementarity" (which is essentially a fundamentally new mode of thought) to this problem, are highly significant and valuable. In any event, the *scientific* description of the "finalism" and pattern-unfolding of life will bear no resemblance to the crude and empty idea of an engineering "specification". Science does not advance by the simple invention of such sonorous substantives (unlike certain forms of philosophy). Indeed, Prof. Kapp's form of "science" reminds one very strongly of the German metaphysical idealism of the romantic Schelling-Hegel period; and perhaps Goethe might have welcomed it at Weimar! It was, however, the advance of real science in the nineteenth century which killed the fantastic *Naturphilosophie,* that weaving of imaginary worlds out of sonorous substantives devoid of verifiable meaning.

There are certain incidental errors in the text: Clerk Maxwell, not Clark Maxwell—a curious mistake for an electrical engineer to make; in several instances, J. S. Haldane and J. B. S. Haldane are comically confused with one another; it will be news to Dr. E. F. Armstrong that he is "the late E. F. Armstrong"—the author probably means his father, the late Prof. H. E. Armstrong.

In conclusion, when one compares the jaunty word-spinning and dialectical jumble of Prof. Kapp with the mystical verbalisms about time written by another engineer, one is tempted to revive, in modified form, an ancient saw: *Ne faber ultra machinam.*

F. G. Donnan.

MAGNETOCHEMISTRY

Magnetism in Relation to Chemical Problems

By Dr. K. N. Mathur. (Lucknow University Studies, No. 8.) Pp. vi + 185. (Lucknow: Lucknow University, 1940.)

MAGNETOCHEMISTRY is a branch of chemical physics in which interest has re-awakened of recent years. In no small measure has this been due to the considerable output and variety of work by Indian workers, and more particularly by Sir Shanti S. Bhatnagar and his collaborators. Bhatnagar has not only initiated, directed, and obviously inspired work in this field, but also he collaborated, in 1935, with the author of the monograph under review in writing "Physical Principles and Applications of Magnetochemistry". Several other texts have been published within the last decade, but there is still a large number of physical chemists (or is it, nowadays, chemical physicists ?) who would welcome a compact, clear, and concise account of what may be called post-Pascal magnetochemistry.

The present volume was written to fulfil this need. The first nineteen pages introduce the subject and deal with various methods of measuring magnetic susceptibility. A discussion of diamagnetism follows and occupies seventy pages. Langevin's theory of diamagnetism and van Vleck's quantum-mechanical theory are reviewed. Ionic susceptibilities, their evaluation by various means from experimental data and their calculation, are discussed, but it is questionable if so much space should have been given to Fajans's theories of deformation of ions. The additivity of diamagnetism and constitutive correction factors are next discussed and lead to applications of diamagnetism in valency problems, in liquid mixtures, addition compounds, polymerization, and in solid solutions and mixtures.

Paramagnetism is dealt with in fifty-seven pages (pp. 91–147) under the following headings : Langevin's theory, intrinsic molecular field, paramagnetism and quantum theory, paramagnetic substances and the influence of temperature and crystalline fields on them, iron group and complex salts, including a discussion, rather extended for the size of the monograph, on general theories of valency. A short chapter of six pages on magnetism in relation to chemical equilibria completes the subject-matter.

Then follow thirty-two pages of references, indexes, and advertisement of other works in the same series ; this seems to be an unduly large proportion of space to devote to these matters, particularly as only one reference, out of the 144 given, refers to work published after 1937. Much interesting work has been published since then, and its non-inclusion is one serious defect in the monograph. Unfortunately, there are others. The proof reading has been very badly done, with the result that typographical errors are frequent ; for example, "sudstances", "struture", "alipahtic", "invarient", "hysterisis", "principle quantum number". Much more irritating, and serious, are errors in mathematical expressions, confusion of symbols, omission of integration limits, and incorrect signs.

While the printing is clear and the format convenient, the style is variable and often careless. The frequent omission of the definite or indefinite article jolts the reader. So also does the use of "analysis" as a plural noun and of "maxima" and "minima" usually, but not always, as singular nouns (*vide* p. 87, which bristles with examples). Ungainly constructions need not necessarily convey wrong meanings, but several which do might be quoted from the monograph ; one must suffice : on p. 23 we read "*In case* [my italics] the atom possesses an initial magnetic moment the small value of the diamagnetic susceptibility may be entirely masked. . . ." Finally, the reviewer feels that he will not be alone in wishing that the statement on p. 12, that water is "easily obtainable in a pure form" were, in fact, really true.

Workers in the field of magnetochemistry will find this book insufficiently up-to-date ; to recommend it to students would be inadvisable, if not dangerous.

W. Rogie Angus.

TOPOLOGY

Lectures in Topology

The University of Michigan Conference of 1940. Edited by Raymond L. Wilder and William L. Ayres. Pp. vii+316. (Ann Arbor, Mich. : University of Michigan Press ; London : Oxford University Press, 1941.) 3 dollars.

THERE is an amazing difference of opinion concerning the importance of topology. Some claim that it is a new type of mathematical thinking, which goes to the heart of qualitative spacial relations, makes complicated analysis intuitively simple, throws light on differential and functional equations, opens a new era in dynamics, and is applicable to problems of electric circuits and of the constitution of chemical compounds. Yet others regard it as a highly specialized subject which can be safely ignored even by geometers, and point out that topologists have not yet solved the apparently elementary four-colour map problem which has been discussed for more than a century.

Topology, formerly called *Analysis Situs*, is the theory of such properties of geometrical figures as are unaltered by stretching or bending (without tearing or joining). From this point of view a sphere is equivalent to an ellipsoid, but differs from an anchor ring. The fundamental problem is to find the invariants. One of the oldest results is the Descartes-Euler relation between V, E, F, the number of vertices, edges, and faces respectively of a polyhedron, namely, $V - E + F = 2$. Instead of a polyhedron, we may take V points on an ellipsoid, and by joining them up in pairs by E arcs divide the surface into F polygonal areas. Then $V - E + F$ is a topological invariant called the *characteristic* and has again the value 2. If we replace the ellipsoid by an (unbounded) surface of *genus* p, for example, a sphere with p holes through it, we get $2 - 2p$. Surfaces may also be classified as *orientable*, if a positive sense of rotation can be assigned consistently at all points, or *unorientable*, and for topological equivalence two surfaces must agree in this respect as well as in characteristic.

However, experts regard all this as merely the infancy of topology. The whole outlook was changed by Poincaré (from 1895), whose definitions and methods, particularly those involving matrices, are fundamental in the modern treatment. His work was n-dimensional and highly abstract, and later writers have still further refined it by introducing the postulational treatment of abstract spaces and the theory of aggregates. The contributions of L. E. J. Brouwer (from 1911) are of great importance. For the last twenty years, topological research has been pursued with enthusiasm in the United States, Poland and the U.S.S.R., but neglected in Great Britain.

The book under review gives the proceedings of the Topology Conference held at the University of Michigan during June 24–July 6, 1940. Twelve lectures are reported in full, and there are summaries of the shorter papers. The first lecture is by Prof. S. Lefschetz, whose well-known book "Topology" is almost indispensable as an introduction to modern work. Other lectures are by R. L. Wilder, N. E. Steenrod, S. Eilenberg, H. Whitney, S. S. Cairns, P. A. Smith, L. Zippin, S. MacLane and V. W. Adkisson, O. G. Harrold, jun., L. W. Cohen, and E. W. Chittenden. They are difficult to summarize for the non-specialist reader, because the subject has made such great progress in America that the problems on which experts are now working are so remote from the simple starting points.

H. T. H. PIAGGIO.

A STEEL-MAKER'S AUTOBIOGRAPHY

Knotted String: Autobiography of a Steel-Maker

By Harry Brearley. Pp. ix+198. (London, New York and Toronto: Longmans, Green and Co. Ltd., 1941.) 10*s*. 6*d*. net.

THE author of this unconventional autobiography is known to many as the inventor of stainless cutlery steel, and to metallurgists as a practical steel maker, a trenchant critic at meetings of the Iron and Steel Institute, and as the writer of several excellent technical books. Those books contain the fruit of long experience in the melting and working of steel and in the conduct of laboratory research, expressed in language of great simplicity and directness, suggesting the hand of a master of English. They have nothing of the aridity of the ordinary text-book. It is therefore interesting to see how a boy, brought up in one of the dreariest parts of industrial Sheffield, came by his peculiar gifts.

The back-to-back houses of Ramsden's Yard must have been unattractive enough; yet the account of life in them pictures a condition of poverty but not of misery, relieved by much neighbourliness and good humour. Brearley's father being a crucible steel melter, the boy, following various casual occupations for a short time only, and receiving only a bare minimum of schooling, became familiar with the small and grimy workshops in which crucible steel, then the aristocrat of steels, was melted and cast. A cellar boy has leisure to study both technical operations and human nature, and this one was a keen observer of both. By good fortune he became bottle-washer in the laboratory of an analytical chemist, an ascetic who had known great poverty, but had managed to study chemistry at home and abroad. One of the peculiarities of this employer, of whom Brearley always speaks with gratitude, accounts for the strange title of the book. With his encouragement, the young assistant became an enthusiastic student, working at science in a night school and in laboratory hours. How he passed from Sheffield dialect to his limpid English style it is less easy to see. From bottle-washer he advanced to the position of assistant, paying the premium of £50 from his weekly wage of 20s. When this was doubled he married, gave popular lectures on science, became an ardent social reformer, and made his first appearance as a writer of scientific articles.

In 1904 he took up an appointment in Riga, where he stayed for four years, managing a laboratory under difficult conditions and acquiring, by hard experience, much knowledge of the treatment of steel and of human material. The Lettish workmen were ignorant and politically restless, and strikes and the revolution of 1905 added themselves to the technical obstacles which arose. How they could be overcome by good humour, common sense and sympathy can be read between the lines of the narrative. In the last part of the Riga period Brearley acted as manager, and then returned to Sheffield to set up a research laboratory for the firm which employed him.

The Riga experience had shown the advantages of such scientific helps to industry as the thermocouple, and in the treatment of such special products as naval armour plate and high steel tools there was ample room for more scientific control, in which this laboratory was a pioneer. In the course of experiments on rifle barrels, with the object of lessening erosion, a steel with a high proportion of chromium was prepared and was noticed in the laboratory to be unusually resistant to chemical reagents. The suggestion that it might be suitable for cutlery was not received with enthusiasm, and it was not until 1914 that a Sheffield cutler became interested and together with the inventor worked out the means of making table knives from the new steel, the difficulty being that the process of hardening was radically different from that used for ordinary cutlery, so that in the beginnings there were many failures. No patent had been taken out, and the subsequent negotiations as to the ownership of the invention make a rather sorry story. A lawsuit in the United States established the originality of the invention and involved a visit to America which left pleasant memories.

In consequence of these disagreements, Brearley left his employers and joined the firm with which he has since been associated. Travels in other countries, including Russia, and partial retirement, bring the story to a close, but there are final chapters containing the author's thoughts on many matters, metallurgical and other. One conclusion on which he insists repeatedly is the value of the experience of the practical man. The old steel worker who judges the quality of steel by the appearance of its fracture and by the feeling as it is worked under his hammer cannot express his valuation in quantitative terms, and his expressions may seem crude to the academically trained metallurgist, but he may have the root of the matter in him. Examples are given of specifications hampering industry because certain limits of chemical composition had become a fetish and had been allowed to overrule the experience of those who had to work the steel.

In another book, "Steel Makers", which vividly describes the old crucible process, the author has suggested means for enabling students to gain a practical knowledge of the operations they hope to control, and throughout both books stress is laid on the pleasure which may be felt in the work of one's hands, whether it be in chemical manipulation, in the working of clay, in carpentry, or in the mending of boots, all of which are referred to in this narrative. The reader feels that he has made the acquaintance of a skilled craftsman, a lover of good literature, of one who can look back with cheerfulness on his early difficulties, and who through varied experiences has attained to a ripe wisdom which leaves him tolerant of much, but not of social injustice.

C. H. DESCH.

SOME ASPECTS OF ALGAL CHEMISTRY*

By PROF. I. M. HEILBRON, F.R.S.
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WHEN I first approached this subject now some eight years ago our knowledge of the lipoid constituents of the Algæ, especially the carotenoid pigments and sterols, was exceedingly meagre. A partial survey of the algal pigments had been made by Kylin[1], but in the light of the precise knowledge of the lipochromes of the higher plants the pigments described by him required re-examination, the more so as his method of detection was purely qualitative and it is uncertain whether the carotenoids described represent distinct chemical individuals. As regards the occurrence of sterols among the Algæ no information whatsoever was available. In view of the recognized importance of these lipoids in relation to physiological factors, and bearing in mind the accepted botanical relationship between colour and classification, it seemed of importance to study both classes of compounds in detail.

Although as yet we have been unable to examine the whole field, we have so far investigated Algæ selected from seven of the eleven classes into which Fritsch[2] classifies them. In the interim, contributions from other laboratories have provided information regarding the pigments of some of the remaining classes, with the result that we now have a clear picture both of the occurrence and structures of these algal constituents. At the same time, as will be shown later, considerable progress has been made in our understanding of the physiological role of the carotenoids in relation to sexual reproduction.

Chlorophyceæ

We have now examined nine individuals from various orders of the Chlorophyceæ or Green Algæ, and in every case carotene and leaf-xanthophyll (mainly lutein) have been detected[3]. *Trentepohlia aurea*, a strictly terrestrial alga, requires special mention, as it is one of the richest sources of carotene hitherto described (compare also Tischer[4]). On the other hand, we have found that xanthophyll is only present in this alga in minute amount whereas in other Chlorophyceæ the xanthophyll-carotene ratio is 2–5 : 1, being thus of the same order as in the higher plants[5,6]. Another interesting observation is that Trentepohlia, unlike other Green Algæ, is wholly deficient in sterol, and in this respect resembles members of the Myxophyceæ. Our examination of the yellowish-green alga, *Zygnema pectinatum*, has revealed the presence of fucoxanthin, which pigment is normally confined to the Phæophyceæ. As no abnormality in the life-cycle or habitat of this alga is known, this raises the question as to whether the presence of this unusual xanthophyll is revealing the phylogenetic past or is forecasting some impending change.

Apart from these exceptions our survey of the carotenoids strongly supports the view held by most algologists that the terrestrial plants originated among the more advanced members of the Chlorophyceæ. Additional weight to the above view is provided from the sterol angle, for we now find that sitosterol, the characteristic sterol of the Phanerogams, is also common to the Green Algæ.

Xanthophyceæ

Unfortunately we have only been able to examine one member of these yellow-green Algæ, the common mud-alga *Botrydium granulatum*. β-Carotene has been definitely identified as the main epiphasic pigment, while in the complex hypophasic lipochromes we have observed the presence of a pigment having well-defined absorption maxima at 4750 A. and 4470A. and giving a strong blue colour with 25 per cent hydrochloric acid. The absorption values are in exact agreement with those recorded by Kuhn and Brockmann[7] for flavoxanthin, and it may well be that this pigment is characteristic of all the Xanthophyceæ. In this connexion it is interesting to note that the only information in the literature concerning the 'xanthophyll' of the Xanthophyceæ is the recognition that it gives a blue colour with concentrated hydrochloric acid. This could apply to either violaxanthin or flavoxanthin, but the spectrographic evidence excludes the former. The sterol present in *Botrydium granulatum* has been found to be sitosterol.

Chrysophyceæ, Bacillariophyceæ (Diatoms)

The only representative of the Bacillariophyceæ which we have so far examined is *Nitzschia closterium*. Of the Chrysophyceæ, a mixture of three members has been investigated, *Apistonema Carteri* Anand., *Thallochrysis litoralis* Anand., and *Gloeochrysis maritima* Anand. From both classes carotene, lutein and fucoxanthin have been isolated, and the analogy extends also to the sterols where we have observed only fucosterol[8]. This analysis supports the view that the Bacillariophyceæ and Chrysophyceæ have points of affinity. From the chemical evidence they would also appear to be related to the more primitive orders of the Phæophyceæ (Ectocarpales).

Phæophyceæ

Here the characteristic pigment is fucoxanthin, $C_{40}H_{56}O_6$. Apart from this pigment, Willstätter and Page[5] record the presence of both carotene and xanthophyll in the Phæophyceæ, although the latter was only assessed colorimetrically and never actually isolated. In our investigations of the Phæophyceæ we have extended the survey to include members from various orders and find that, despite the great diversity in the life-cycles of the individual species, all reveal the most marked uniformity of pigmentation, with fucoxanthin as the main hypophasic pigment, lutein only being demonstrated spectrographically in the lower members. Another striking feature of the Phæophyceæ is the universal occurrence of fucosterol and total absence of sitosterol; this, again, sharply differentiates the Phæophyceæ both from other Algæ and from the higher plants.

Rhodophyceæ

In general agreement with Kylin[1] we find the lipoid pigments to be carotene and lutein in all members of the seven orders examined, while the normal sterol appears to be sitosterol. An unexpected abnormality has been observed in the case of *Polysiphonia nigrescens*, an alga of striking red-black colour, which contains both fucoxanthin and fucosterol in addition to carotene and lutein. This abnormality of pigment and sterol is curious, as

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* Substance of the Eighth Hugo Müller Lecture delivered to the Chemical Society on October 16, 1941.

Polysiphonia nigrescens is morphologically a perfectly normal diplolbiontic member of the order Ceramiales. The closely related *Polysiphonia fastigiata* is quite regular in pigment and sterol, despite its parasitic habitat on the brown alga, *Ascophyllum nodosum*.

Myxophyceæ (Cyanophyceæ)

These Blue-Green Algæ contain a specific carotenoid for which the name phycoxanthin was originally suggested by Kraus and Millardet in 1866. A more detailed examination of a member of this class (*Calothrix scopulorum*) was made by Kylin who, using his capillary method, qualitatively noted carotene together with three other pigments to which he gave the names myxorhodin-α and -β and calorhodin.

In 1935 my co-workers and I isolated from the terrestrial alga *Rivularia nitida*, in addition to carotene and lutein, another epiphasic carotenoid in crystalline form, for which the name myxoxanthin was suggested[9]. The same pigment was also found in a related marine species, *Rivularia atra*, and later[10] in the freshwater member, *Oscillatoria rubrescens*, from which source a second new pigment, myxoxanthophyll, was also isolated. The quantity of material available has unfortunately precluded a detailed examination of the latter, but analysis has given the formula, $C_{40}H_{56}O_7$, while, from the tenacity with which it is retained by alumina on a column, it obviously contains, like fucoxanthin, a multiplicity of hydroxyl groups. Unlike myxoxanthophyll, myxoxanthin is epiphasic, being a typical carotenoid monoketone having the formula $C_{40}H_{54}O$.

Tischer[11] has independently examined the carotenoids of another blue alga, *Aphanizomenon flos-aquæ*, from which he isolated four pigments, principally an epiphasic lipochrome which he named aphanin and a hypophasic member, aphanizophyll. Of these, aphanin is seemingly isomeric with myxoxanthin, according to Tischer being derived from β-carotene and not from γ-carotene as is the case with myxoxanthin. It is thus clear that the Myxophyceæ synthesize their own typical pigment which differentiates the class quite sharply from other Algæ.

Another striking feature, which we have noted, is the complete absence of sterols; bearing in mind that there is a total lack of sexuality in this class, the question as to whether any correlation exists between the presence of sterols and sexuality naturally frames itself, and although no definite answer can at this stage be supplied, it opens up an intriguing avenue for further investigation. If any significance is to be attached to sterol content in relation to the physiological phenomenon of reproduction, the question of *Trentepohlia aurea*, of which mention has already been made, comes under review. Whereas, so far as is known, this alga is sexually normal, it nevertheless is now growing in a habitat unusual for a Green Alga and, moreover, the genus is normally tropical. It may be that the disappearance of sterol in both the temperate and terrestrial conditions forecasts an impending loss of sexuality. It is also perhaps not merely coincidence that the bacteria, which are also lacking in sexuality, are likewise totally devoid of sterols.

Euglenineæ

Together with the Green Euglenineæ, members are known which are deep red in colour (for example, *E. sanguinea*), due to the presence of a red pigment for long known to botanists as hæmatochrome. Tischer[12] has recently examined *Euglena heliorubescens*, a rich source of this red pigment which he calls euglenarhodon and which he claims is a tetraketone[13] isomeric with astacene, $C_{40}H_{48}O_4$, the characteristic pigment of the Crustacea. Kuhn, Stene and Sörensen[14] have independently isolated the same pigment from the red spores of the green alga, *Hæmatococcus pluvialis*, and have shown that it is actually identical with astacene. The natural pigment is not, however, astacene, but a closely related ester of a xanthophyll to which the name astaxanthin, $C_{40}H_{52}O_4$, is given, and which readily passes into astacene through aerial oxidation during hydrolysis.

The occurrence of astaxanthin in the Euglenineæ is of especial interest in view of the position occupied by these flagellates in bridging the gap between the vegetable and animal kingdoms. Its presence in *Hæmatococcus pluvialis* is more difficult to comprehend; it may be noted, however, that the red pigment is apparently not present in the normal green motile Sphærella, but only makes its appearance at the onset of the resting phase or with variation in constitution of its habitat. The occurrence of eyespots (stigmata) in nearly all motile cells of the Algæ merits attention. These appear as a reddish or brownish-red dot in the superficial layer of the cytoplasm and the pigment has for long been considered by botanists to be hæmatochrome. In view now of our more precise knowledge, there can be little doubt that it is actually either astaxanthin or astacene.

Pigmentation and Sexual Reproduction

This problem has been examined in great detail during the past decade by the botanist F. Moewus[15], first at the Kaiser Wilhelm-Institut für Biologie at Berlin, and later in association with R. Kuhn at Heidelberg. For the purpose of their researches use was made in the first instance of the unicellular green alga *Chlamydomonas eugametos f. simplex*, in which the male and female gametes are morphologically identical (isogamous). As grown on an agar medium the gametes are devoid of cilia, but if they are suspended in distilled water and illuminated, the cilia develop in the course of about three minutes and after irradiation for a further two minutes these begin to oscillate and the cell becomes motile. The same effect can be brought about in the dark, but here oxygen is necessary and the distilled water is replaced by 1 per cent of glucose. It can be induced by the addition of a cell-free filtrate of gametes which has already become motile in light to a suspension of a dark culture even in absence of oxygen. This latter experiment proves that a definite chemical substance has been released into the water by the action of light. This substance has been identified with almost complete certainty as the saffron pigment crocin[16], the digentibiose ester of the carotenoid acid crocetin, $C_{20}H_{24}O_4$, and has been shown to be effective in producing motility at the astonishing dilution of 1 : 250,000,000,000,000.

Even though the gametes have thus become motile, they are still unable to copulate, which property they only acquire on further prolonged illumination. Unlike the first, this second photochemical process is effected only by irradiation with blue or violet light, the active wave-lengths being the two mercury lines at 4358 A. and 4961 A. The period of illumination is specific, being shorter for the female than for the male gametes, while over-irradiation gives only inactive filtrates. That here, again, definite chemical substances are formed and discharged into the surrounding solution is shown by the fact that it is not essential to irradiate the sexual cells themselves in order to produce the copulatory materials. One can first illuminate a male or female cell suspension activated in the dark with glucose and oxygen, with red light (6463 A.) for one hour and then filter and expose the inactive 'red' filtrate (V) to the further action of short-wave light, when the copulatory substances are again formed. The time required for attainment of 'female properties' by the filtrate is from 20 to 30 minutes ($K_{\text{♀}}$); after a longer time it becomes unable to confer on female 'dark' cells ability to copulate. After sixty minutes, however, the filtrate acquires the property of rendering male 'dark' cells active ($K_{\text{♂}}$), while after ninety minutes' irradiation the filtrate (K_0) becomes permanently inactive.

All these phenomena can be exactly reproduced if, in place of the filtrate (V), the light-sensitive pigment, *cis*-crocetin dimethyl ester, is employed. Under the influence of light this is converted gradually into the *trans*-form and it has been found that for this particular race of Chlamydomonas the material conferring copulatory activity on the female 'dark' gametes is a mixture of three parts of *cis*- and one part of *trans*-crocetin dimethyl ester. For the male 'dark' gametes the ratio is three parts of the *trans*-isomer and one part of the *cis*-ester. The V-material is perhaps the labile *cis*-crocetin dimethyl ester and the $K_{\text{♀}}$ material the *trans*-isomer. The biological limit of activity of both esters is found at a dilution of 1 : 33,000,000,000 which, great as this is, is not comparable with the effect of crocin in bringing about cell-motility.

In a still more recent memoir[17] considerable light is thrown upon the question of control of sex. For this purpose the hermaphroditic green alga *Chlamydomonas eugametos f. synoica* was selected. If this is treated with a filtrate of male gametes of the diœcious strain all the cells become male, while, conversely, a filtrate of female gametes renders all the cells female. It thus follows that the gametes must also secrete substances (termones) controlling sex. Although the termones in the active filtrates have not so far been isolated, it has been ascertained that the relationship of gynotermone to androtermone is of the type glycoside to aglucone. The fact that, unlike glycosides in general, the female termone is hydrolysed by alkali suggested that it might be picrocrocin, and the physiological activity of this compound was demonstrated. Although the authors consider that safranal is identical with the natural androtermone, the corresponding gynotermone is shown to be a thousand times more active than picrocrocin, and this they attribute to the presence of a sugar residue other than glucose, and possibly gentiobiose. Perhaps the most outstanding feature of this brilliant series of investigations is the remarkable insight it provides of the versatile manner in which Nature utilizes one substance only, the carotenoid crocin (or the as yet undetected protocrocin), to carry out numerous sexual functions. Kuhn[18] has recently announced the existence of an enzyme in male gametes capable of effecting the fission of picrocrocin. This glycoside-splitting ferment is in all probability localized in the cell nucleus, and this he considers may be a fundamental constituent of the chromosomes and, indeed, may be actually identical with the gene M (controlling masculinity).

In *Chlamydomonas eugametos* we have been dealing with a species where sexual reproduction is isogamous, and I now wish to direct attention to the question of oogamous reproduction among Algæ. In this connexion the diœcious members of the Fucales, such as *Fucus serratus*, are especially convenient as large quantities of both male and female gametes can be obtained in a pure state. The numerous biciliated sperms contain a small yellowish chromatoplast, and the mature antheridia therefore appear orange-yellow, which colour they impart to the entire receptacle. It appeared to my colleague, Mr. P. W. Carter of the Botany Department, Aberystwyth, and myself that an investigation of the nature of this yellow pigment might shed light on the fundamental process of sexual reproduction. At the time this investigation was commenced we were not aware of the researches of Kuhn and Moewus, and in any event the problem is different, as here only the male sperms are motile. Our experiments[19] have been carried out with *Fucus serratus*, *Ascophyllum nodusum* and *Fucus vesiculosus*, and have revealed that the pigment present in the male gametes consists almost entirely of β-carotene. In direct contrast to the results obtained with the male exudate, the examination of the corresponding female exudate has revealed that the colour of the ova is due solely to chlorophyll and fucoxanthin. As β-carotene is to be observed only in the male gametes it may be that this carotenoid is bound up with their motility. Perhaps under the influence of light and in presence of oxygen the hydrocarbon becomes oxidized to crocetin which then acts in a similar manner as with Chlamydomonas. The association of carotene with sexual processes is further suggested by recent work carried out by Emerson and Fox[20], who have observed that in the case of the aquatic fungus Allomyces, the orange colour of the motile male gametes in the sexual phase is due to γ-carotene.

Another problem to be elucidated in connexion with the sexual process in these Fucaceæ is the mechanism whereby the motile male gametes become attracted to the egg. Kuhn and Wallenfels[21] have shown that in the case of the sea-urchin this is brought about by the ova secreting a compound, echinochrome A, into the sea-water. It may be that fucoxanthin plays a similar part in these algal ova or that something akin to echinochrome is secreted. This latter possibility is supported by the fact that we have obtained cell-free extracts of ova of *Fucus serratus* which attract the sperms. It is our intention to investigate these matters in greater detail at a more opportune moment.

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[1] Kylin, *Z. physiol. Chem.*, **166**, 39 (1927).

[2] Fritsch, "The Structure and Reproduction of the Algæ", Vol. 1. Camb. Univ. Press (1935).

[3] Carter, Heilbron and Lythgoe, *Proc. Roy. Soc.*, B, **128**, 62 (1939).

[4] Tischer, *Z. physiol. Chem.*, **243**, 103 (1936).

[5] Willstätter and Page, *Annalen*, **404**, 237 (1914).

[6] Seybold and Egle, *Jahrb. wiss. Bot.*, **86**, 50 (1938).

[7] Kuhn and Brockmann, *Z. physiol. Chem.*, **213**, 192 (1932).

[8] Heilbron, Parry and Phipers, *Biochem. J.*, **29**, 1976 (1935).

[9] Heilbron, Lythgoe and Phipers, NATURE, **136**, 989 (1935).

[10] Heilbron and Lythgoe, *J. Chem. Soc.*, 1376 (1936).

[11] Tischer, *Z. physiol. Chem.*, **251**, 109 (1938).

[12] Tischer, *Z. physiol. Chem.*, **239**, 257 (1936).

[13] Tischer, *Z. physiol. Chem.*, **250**, 147 (1937); **252**, 225 (1938).

[14] Kuhn, Stene and Sörensen, *Ber.*, **72**, 1688 (1939).

[15] Moewus, *Arch. für Protistenkunde*, **80**, 469 (1933).

[16] Kuhn, Moewus and Jerchel, *Ber.*, **71**, 1541 (1938).

[17] Kuhn, Moewus and Wendt, *Ber.*, **72**, 1702 (1939).

[18] Kuhn, *Angew. Chem.*, **53**, 1 (1940).

[19] Carter, Cross, Heilbron and Jones, unpublished work.

[20] Emerson and Fox, *Proc. Roy. Soc.*, B, **128**, 275 (1940).

[21] Kuhn and Wallenfels, *Ber.*, **72**, 1407 (1939).

FOUNDATIONS OF THE NEW WORLD ORDER

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POST-WAR economic reconstruction is neither possible nor desirable. We reconstructed after the War of 1914–18. The system wobbled in the world economic crisis of 1929; it has now crashed in the present War. Its doom is deserved. A system which, of set purpose in the interest of a few, limited the production and distribution of food and other necessities of life urgently needed by the vast majority of men, is incompatible with human welfare. With the old economic system goes its superstructure, the international political system under which we have suffered two world wars in one generation. The old world order is in its death throes.

Piecemeal planning for such limited objectives as the restoration of the sovereign rights of small States, the adjustment of political boundaries for a new balance of power or, in the economic field, for new trade agreements and the restitution of trade union rights, on the assumption that after the War things will be pretty much as they were before, is worse than a waste of time. It diverts men's minds from the real task, which is the building of the new world in which all men in all lands will enjoy the freedom from fear and freedom from want promised in the sixth article of the Atlantic Charter.

The old world, which had within it both good and evil, is undergoing a metamorphosis. The good and the evil are struggling for supremacy. The call of the new world is a challenge to the human race. Has man the higher spiritual attributes needed to build it? Has he the intelligence to recognize irreversible changes now taking place in human society and the goodwill to direct these changes along lines calculated to promote human welfare?

An evident irreversible change is the transition to a World State. Science has eliminated distance. To-day, the countries of the world are in closer contact than two adjacent counties in England were a hundred years ago. Phases of a World Government have been evolving rapidly since the time the first steamship crossed the Atlantic. Finance, trade, science and even sport have come under some form of international control, and Governments have united in organizations, such as those for the control of infectious diseases, and an international postal system. The last phase will be the organization of a properly constituted Government based on a sound world economic policy with a world police to maintain law and order. This will carry through and complete the task begun half-heartedly when the League of Nations was set up after the War of 1914–18.

The real issue of the War is whether the World Government will be the kind imposed by the Nazis in Europe, which means a throw-back to the more primitive form of social order based on slavery and maintained by brute force, or a democratic Government in which nations will co-operate for their mutual benefit.

The Nazis have an advantage in the struggle because they fully realize they are fighting for world dominion and they have created an enthusiasm among the German youth for their new world in which they will be the *Herrenvolk*. We, on the other hand, while willing to fight to the death to defend ourselves against Nazism, have no clear vision of the future to enthuse our own people and the people of all other lands for an offensive war as a crusade to establish the new and better world. We have not yet even reached agreement on the kind of world we are fighting for.

The only way to reach agreement is to go back to fundamentals. All men of goodwill would agree that the first duty of Government is to provide the necessities of life for the people governed. The material necessities of life are (1) food and (2) shelter, which includes a house, furniture, clothing and warmth. To these must be added (3) work, which is a psychological necessity. The British Commonwealth, the United States, the U.S.S.R., China and all the other nations opposing Nazism could reach agreement on a simple positive programme based on providing the necessities of life for the people.

This may appear a rather meagre programme. As a matter of fact, even in the wealthiest countries, we could not complete this programme in less than ten years. A third of the population in the United Kingdom and about an equal proportion in the United States do not enjoy food and shelter on the standard needed for health. In most other countries, the proportion of the population which has never been adequately fed or adequately housed is even higher. Among native races, for whose welfare Britain is responsible, only a relatively small proportion of the population have reached that economic level.

If every family had a home in which they could live in decency, food on the health standard and a feeling of absolute security that they would never fall below that level, we should have an economic and social foundation upon which we could begin to build a new world which, in time, would provide for a still fuller life.

This simple plan of providing for human needs on a health standard has the great advantage that we know what we are planning for. The needs are known. We can measure them and estimate the time it will take to provide them.

I have outlined elsewhere a national food policy which would fit in with the world plan and would enable post-war food relief for Europe to dovetail smoothly into a permanent policy. The scheme suggested would involve less interference with the freedom and initiative of the farmer and trader than was involved with the pre-war marketing board schemes.

While food can be planned on a world scale, housing varies so much with climate that it is a national problem. In Great Britain the only way to get all families housed in our day is by a temporary housing scheme. In Scotland, after seventeen years of Government housing schemes, during which 280,000 houses were built, there were still 250,000 families needing decent homes. This was the position just before the War. The number needed by the end of the War may be about 400,000. In England it will be more than 2,000,000. These families cannot wait for a home until we have completed plans for the better location of industry and for new towns. A *temporary* housing scheme, providing houses on a minimum standard of whatever material is available, should be undertaken immediately the fighting finishes. An advantage of a temporary scheme is that it would give time to see what industries are likely to be after the War and where they can best be located. Within, say, ten years, these houses could be replaced by more permanent and better houses. We need not worry about the waste involved in a temporary housing scheme. Our capacity for production after the War will be increased to such an extent that there will be difficulty in getting an outlet for the products. In any event, the waste of human life involved by existing slum conditions is more important than the waste of material.

As Mr. Roosevelt has pointed out, the standard of living of the masses of the people is so low that if we undertook to provide satisfactory homes and adequate food for everybody, there would be work for every man and woman seeking a job. But provision must be made for men temporarily out of employment, and every man, rich or poor, should be made to do some useful work. A National Service Corps would provide for this. The men in the Corps could be employed on national or local government work. Every man should be forced to serve for a year before he reaches twenty-one years of age. After a year's service, a man would be free to leave. He would also be free to return if he wished and could not find employment. After a man had served a number of years calculated to be sufficient to pay for the bare necessities of life on a health standard for himself and his family, he could retire and enjoy these with the same dignity and self-respect as a man drawing an endowment for which he had paid all the premiums.

This plan for adequate food, a decent home and security for every family would bring about a social revolution. Bringing food and housing among the poorest third of the population up to the standard for health would reduce disease and improve national health and physique. Poverty in the old sense of the term would be gone for ever. A great part of our social and public health services and most of our charities would become unnecessary. The unemployment problem would be solved. Every family would have security for a good home. For the first time in history, the common man would enjoy economic freedom and the means of attaining his full physical and spiritual manhood.

This plan would also lay the foundation for agricultural and economic prosperity. It is estimated that in the United States the production of the protective foods, for example, milk, eggs and fruit, would need to be increased from 15 per cent in the case of some to 100 per cent in the case of others. Similar increases are required for Britain and larger increases for most other countries. The production of this additional food would call for a great expansion of agriculture. To enable agriculture to produce the food needed the great majority of farms in Britain would need to be re-equipped. The same is true of almost all other countries, including the United States. The re-equipment of agriculture would provide an outlet for an enormous amount of industrial products. When production had reached a level which would supply human needs there will be a permanent increase in the trade in food and in the commodities exchanged for food. A food policy based on human needs would be the spear-head for agricultural and economic prosperity.

A policy of providing first for human needs, as outlined here, would be so revolutionary and so beneficial that it would be wise to concentrate on it and leave all industries not directly concerned with the necessities of life to the free play of private enterprise. This would provide for the flexibility needed for the adjustment of industry and trade to the advances of science.

This plan for building the new world from the bottom upwards would give expression to our growing spiritual idealism. Every great spiritual awakening calls for sacrifice. This plan involves sacrifice. In Britain those who already enjoy the necessities of life on a health standard—and that includes the well-paid workman—would need to stand back from the national table until those worse off are served. To accomplish the world food plan, the wealthy nations must give to the poor nations food, agricultural equipment and the other things needed to provide the necessities of life, not against a loan which would sink the poorer nations in debt, but on a world-wide lease-lend plan arranged by an international financial organization, the security of which would be guaranteed by all nations, including the poorest. The poorer nations would not be encouraged to pay interest in the form of money or exports which would delay the provision of the necessities of life on a health standard for the whole of their population. When they had reached that level, they could begin to pay their debt in money or in kind. The nations would find their spiritual and economic salvation in this policy of giving.

This may seem Utopian. It is merely the policy of the good neighbour. Any ordinary citizen would give food to a neighbour needing it, demanding nothing in exchange immediately. Until Governments in their dealing with each other reach the moral standard which regulates neighbourly relations, the world will never be free from war.

The adoption of this plan would remove the feeling of uncertainty and apprehension as to what is going to happen after the War. Everyone would know what they were fighting for and working for. The people in the occupied countries in Europe and even in Germany itself would know what our peace aims are. They could be told incessantly, day and night, that when our armies invade Europe they will bring the food ships with them, and that the United Nations will continue to send food and other things needed not merely for post-war relief but until each country, including Germany, is in a position to provide the necessities of life on a health standard for the whole population. We could, in terms which would carry conviction, call upon the people of all countries to join with the armies of the free to carry through the glorious revolution for the destruction of the forces of evil, and the establishment of a new World Order in which the nations will co-operate to bring freedom from the fear of war and freedom from want to all men in all lands.

QUANTUM THEORY AND DIFFUSE X-RAY REFLEXIONS

IN the article by Mr. G. D. Preston which appeared in NATURE of April 4, a descriptive account was given of the theory put forward by Sir C. V. Raman in a series of papers published in the *Proceedings of the Indian Academy of Sciences* to explain the extra spots on Laue and other types of X-ray photographs. We are here adopting a much more critical attitude.

Raman has emphasized the fact that when X-rays are scattered by a vibrating system, the scattered beam contains components of changed frequency. It is not, however, made clear either in the Symposium or in Preston's account of it that this is a consequence both of classical and of quantum theory. From the classical point of view it is the Doppler effect for the reflexion of X-rays by waves of atomic vibrations; in quantum language it is the transfer of energy from a photon to an acoustical quantum, or vice versa. This frequency shift has long been acknowledged by the thermal theory. Since the frequency changes are much too small to be observed, they are not of practical significance except in so far as they are intimately connected with the incoherence of the scattered rays, which is an essential feature of the phenomenon.

Raman also gives the impression (which is not refuted by Preston) that his theory is a "quantum" theory and that the thermal theory is a "classical" one. The exact opposite is the case. As Preston remarks, Raman's presentation is obscure, but it is clear enough that at no stage (except when he introduces the effect of temperature change) does Raman make use of quantum mechanisms at all. He does not attempt, for example, to calculate the intensity with the help of transition probabilities. The thermal theory, on the other hand, although originally presented, nineteen years ago, in a semi-classical form, has since been given a strictly quantum-mechanical basis. The facts are that Raman's "excited vibrations" must exist (either from a classical or a quantum point of view), but that their contribution o the scattering is extremely small as compared with the effect of the thermal vibrations.

All the experiments described by Raman and his olleagues are in entire accordance with the thermal heory, but experiments on metals and on the "forbidden" reflexions of diamond, which he did not ttempt, definitely prove that his theory cannot ccount for the facts. We have outlined some of our rguments in the following communications (written efore we had read Mr. Preston's account) and have laborated them in papers to be published elsewhere.

M. B.
K. L. and H. S.

Sir C. V. Raman's theory of the extra spots on aue photographs having now been published in etail, I wish to deal with the theoretical aspect, as believe it is now possible to show exactly where aman's statements are incorrect.

(1) Raman assumes that the extra spots are due ot to the acoustical (low-frequency) branch of the ibrational spectrum but to *monochromatic infra-red brations*.

This assumption contradicts the results of lattice ynamics, which show that the elastic spectrum nsists of different branches, each of N vibrations N number of unit cells), uniformly distributed in ciprocal space (co-ordinates: components of wave ctor $\mathbf{q}$). In order to justify this contradiction, aman points out that lattice theory uses the method the 'cyclic lattice' (replacing the boundary contions by the postulate of periodicity in a parallel-iped of N cells), a method which he says is not oved but arbitrarily invented to simplify the athematical treatment. As a matter of fact, it is t proved, apart from a simple example (chain of ual particles) and a limiting case (continuous edium). These cases show, however, that the cyclic ethod is not arbitrary, but mathematically reasonle; and it is also well confirmed by its applications r example, conductivity of metals). As Raman tacks the validity of the method, in particular for e optical branches, I have rigorously solved the problem of a finite di-atomic one-dimensional lattice (chain of two alternating particles); the result is, of course, uniform distribution of the frequencies in both branches and the same law for their dependence on wave number as given by the cyclic method.

The intensity of X-ray scattering of all branches will be incoherent and proportional to N. Raman's contention that the scattering due to an excited infra-red vibration will be coherent and proportional to N^2 has no theoretical justification whatever.

(2) Bisheshwar Dayal attempts to support Raman's assumption of monochromatic infra-red vibrations by calculations about the *specific heat* of metals, which he contends cannot be represented by a Debye function but needs additional terms of the Einstein type. This suggestion is not new; it was given in my book "Dynamik der Kristallgitter", published in 1915 (formula 200, p. 77), where I showed that the optical branches of the lattice oscillations are narrow bands which for the calculation of specific heat can be approximately replaced by one frequency. It is clear that no support for Raman's hypothesis can be obtained from a formula previously derived from lattice dynamics.

(3) Raman considers the *sharpness of the lines* observed in the optical Raman spectrum of crystals as a proof of the monochromatic character of the infra-red vibrations. It is not. Lattice theory explains it as a consequence of the optical selection rule: emission of light waves will not occur for every case of resonance, since the electric moments of the different cells of the crystal are in general out of phase; it is restricted to long waves for which the phases in a large group of cells are equal, and this corresponds to an extremely small region of the reciprocal space near the point $\mathbf{q} = 0$. To each 'optical branch' of frequency there belongs only one sharp 'optical resonance'. (I regret if the term 'optical branch' has led to this misunderstanding; but the facts are clearly stated in several publications.)

(4) Raman's proof that *the acoustical branch cannot produce sharp spots* is, shortly, the following: The scattering is proportional to the mean square of the amplitude of vibration, $\overline{\xi^2}$. On the other hand, the mean potential energy of an oscillator of angular frequency ω, $\frac{1}{2}\,\omega^2\,\overline{\xi^2}$, is equal to half the mean total energy $\frac{1}{2}kT$, $(\hbar\,\omega << kT)$, hence $\overline{\xi^2} = kT/\omega^2$. Raman replaces ω by $2\pi c/\lambda$, where λ is the wave-length of the elastic wave, c the velocity of sound. Thus he obtains the scattering of the acoustical branch proportional to $kT\lambda^2$, which is a smooth function and cannot give rise to spots.

The fallacy of this argument lies in the assumption that c is a constant. It is not. In fact, the relation between λ and ω is involved. ω is a periodic function of the components of the wave vector $\mathbf{q}$ (length $q = 1/\lambda$). Consider as illustration the oscillations of a set of parallel equidistant planes in the lattice (spacing a) which will be roughly the same as that of a chain of equidistant mass points (linear lattice); it is well known that the frequency in this case is $\omega = \omega_0\,|\sin(\pi a/\lambda)\,| = \omega_0\,|\sin(\pi q/b)\,|$, where $b = 1/a$ is the lattice constant of the reciprocal lattice. The dynamical theory of the scattering leads to the same result as de Broglie's quantum condition: the intensity is enhanced if the difference of the momentum vectors for the incident and reflected photon is equal to the momentum of the acoustical quantum, or $2\,Q\,\sin\,\delta = q$, where $Q = 1/\Lambda$ is the wave number of the X-ray. (As the left-hand term may have any value, q cannot be restricted to the domain $0 \leqslant q \leqslant b/2$, or $2a \leqslant \lambda \leqslant \infty$, for which $\omega(q)$ assumes all possible values.) Taking for the mean square amplitude Raman's approximate expression kT/ω^2, the 'scattering power' is proportional to

$$S(q) = \frac{kT}{\omega_0{}^2 \sin^2(\pi q/b)},$$

and the intensity for the direction δ is $S(2Q \sin \delta)$. $S(q)$ is a periodic distribution in the 'reciprocal space' q; it has sharp peaks (infinities) at the points of the reciprocal lattice $q = 0, b, 2b, 3b, \ldots\ldots$ These correspond to the Bragg reflexions; for $2Q \sin \delta = nb$ is the same as $2a \sin \delta = n\lambda$.

If all possible sets of reflecting planes are simultaneously considered, the formulæ are more involved, but the principal features unaltered: the scattering power $S(\mathbf{q})$ is a function of the three components of the wave vector $\mathbf{q}$, and the scattered intensity due to the vibrations is $S(\mathbf{Q}' - \mathbf{Q})$, where $\mathbf{Q}$ and $\mathbf{Q}'$ are the wave vectors of the incident and scattered beam (of practically equal length). $S(\mathbf{q})$ consists of additive terms each corresponding to one branch of the vibrational spectrum, and these have peaks (infinities) for the acoustical branches in the points of the reciprocal lattices (which correspond to the Laue spots); but the terms for the optical branches are quite smooth functions, as for these $\omega(\mathbf{q})$ does not approach zero.

Hence the correct theory attributes the observed extra spots to the acoustical vibrations—just contrary to Raman—and this is well confirmed by experiments of Lonsdale and Smith on various metals.

The optical branches may give broad but relatively weak intensity maxima halfway between Laue spots because $\omega(\mathbf{q})$ has minima there (in the linear case for $q = \frac{1}{2}b, \frac{3}{2}b, \frac{5}{2}b, \ldots.$).

(5) Raman claims that the extra spots are due to a peculiar *new type of quantum effect*. His theory, as now made known, is however completely classical, whereas the so-called 'thermal' theory based on lattice dynamics (which Raman rejects) is developed strictly on quantum principles. The only point where Raman introduces a quantum consideration is in respect of the temperature dependence of scattering produced by his monochromatic infra-red vibrations. With the help of strange reasoning he obtains a formula which is in fact (apart from a factor of 2) identical with the formula for the energy of an oscillator with zero-point energy, according to Planck. Now this quantity determines the intensity also in the theory based on lattice dynamics.

Venkateswaran tried to confirm Raman's assumption by deriving the characteristic frequency in the Planck formula from the observed temperature effect of the extra spots, and to compare it with other determinations of infra-red vibrations (Raman effect). These observations had to be made on extra spots well separated from the corresponding Laue spots and would therefore in any case refer to oscillations of relatively high frequency. All the experiments showed was that for carborundum the oscillations were of higher frequency than those for a soft organic crystal, a result which the theory of lattice dynamics undoubtedly predicts, because of the differences in the quasi-elastic forces in the two substances.

(6) In order to explain the *specific intensity of extra spots* corresponding to different Laue spots, Raman introduces special assumptions about the directions of his monochromatic waves. Lattice dynamics provides the explanation without any assumption, by expressing the scattering power $S(\mathbf{q})$ as a function of the quasi-elastic forces between the atoms. These can be approximately expressed in terms of the elastic constants (Zachariasen, Jahn, Sarginson). Jahn has shown that the elastic anisotropy of cubic crystals leads to a characteristic anisotropic distribution of $S(\mathbf{q})$ around each point of the reciprocal lattice; Lonsdale and Smith have used Jahn's formula very successfully for representing their observations.

The extra spots are not, as Raman assumes, in contradiction to lattice dynamics, but provide a powerful method of checking it in every detail.

University of Edinburgh. MAX BORN.

Prof. Born and Miss Sarginson[1] have pointed out that according to the quantum mechanical calculations of Ott (1935) and also from the point of view of Placzek's quasi-classical theory, the excitation by the X-ray energy of characteristic crystal vibrations (analogous to the Raman effect in light scattering would only be expected to give X-ray interference effects entirely secondary in importance to those o the thermal vibrations. Ott[2] suggested, however, tha in regions where a Bragg reflexion would normally be forbidden, the Raman effect might possibly giv an observable reflexion, and questioned whether th 222 reflexion from diamond might not be such a instance.

This suggestion has recently been revived by Si C. V. Raman[3] (who does not, however, either admi the secondary importance of the excited vibration or refer to Ott's paper) and has been worked out i quantitative detail by P. Rama Pisharoty[4], on th basis of an excited 1,332 cm.$^{-1}$ oscillation *normal t one set of* (111) *planes only*. This procedure we believ to be incorrect and misleading, since such oscillation if excited at all, will certainly take place with equa probability normal to all the {111} planes. However, Pisharoty makes the following predictions fo a perfect diamond set for reflexion at the Brag angle appropriate to each plane in turn:

(1) There is no 222 Bragg reflexion, but tha there is a 222 extra reflexion (which he alternate calls a modified, quantum or Raman reflexion), th intensity of which is roughly equal to that of the 11 extra reflexion.

(2) There is no 220 extra reflexion, or alternatively, that if there is, it will be *very* much weak than the 111 extra reflexion. He reports that D Nilakantan has failed to find such a reflexion i spite of many trials.

(3) There is no 200 Bragg reflexion, but th there is a 200 extra reflexion. The intensity of th extra reflexion he estimates to be about one thi of the 222 intensity, but in so doing he has neglect to allow for the difference in Bragg angle. Actuall his theory would make them nearly equal.

We have investigated these reflexions with th greatest care, and have fully established the followi experimental facts:

(1) The 'forbidden' 222 reflexion is in every re pect similar to a Bragg reflexion and has none the peculiar characteristics of an 'extra' reflexio It appears sharply at the appropriate Bragg an (for our *D*(2) diamond its intensity was about 0 of that of the 111 Bragg reflexion), and when t angle of setting is varied it disappears complete even when the exposure given is several times long as that required to record the 111 extra refle

ions with appreciable intensity in positions of equivalent mis-setting. The 222 reflexion was examined in both possible diamond orientations ($[1\bar{1}0]$ axis vertical) and no sign whatever was found of the detail that would correspond to intensity spikes along cube directions in reciprocal space (that is, of any effect geometrically analogous to the 111 streaks and triangles).

(2) The $\{220\}$ planes, in all orientations, do give extra reflexions, both primary and secondary[5], which are at least half as intense as the 111 extra reflexions. We cannot understand Dr. Nilakantan's failure to find them.

(3) There are no reflexions of any kind from the (200) planes, of intensity comparable with that predicted, or even as much as 1 per cent of that value.

We used both direct and monochromatized (copper $K\alpha$) radiation from a 5-kw. tube. In order to avoid all possible errors of setting, we took series of Laue photographs at 0·2° intervals, and also 1° and 5° oscillation photographs. Exposures varied from 5 seconds to 2 hours. Using X-radiation monochromatized by reflexion from the (001) plane of urea nitrate, a weak reflexion was observed in the 200 position; its intensity was about 0·01 of that of the 222 reflexion (exposures of one hour and 30 seconds were required to record the two with comparable intensities) and about 0·0003 of that of the 400 Bragg reflexion. It was certainly due to the 400 reflexion of wave-length $\lambda \text{Cu}K\alpha/2$. Such 'unwanted' radiation is unavoidable in any monochromatized beam if the monochromatizing plane used has a second-order reflexion, and it sometimes amounts to as much as 1·6 per cent of the λ component[6]; for precise work it should always be estimated and allowed for. (Such a $\lambda/2$ component probably accounts for the doubtful 100 reflexion on a monochromatic photograph of sodium chloride, referred to by C. S. Venkateswaran[7].)

P. Rama Pisharoty and R. V. Subrahmanian[8] observe that the absence of the 111 extra reflexions (of the secondary kind) in type II diamonds[9] is due to the probable mosaic structure of these rare specimens. There are not, they suggest, sufficient cooperating planes in each block for the subsidiary phenomena to appear. In a reply to this suggestion it may be pointed out:

(1) That the 222 reflexion (which they have claimed to have the same origin as the 111 subsidiary reflexions) does appear quite strongly in type II diamonds. The larger value of the 111/222 intensity for such diamonds as compared with that for type I is due to the very much greater 111 intensity, not to a decrease in 222.

(2) That the secondary effects were observed so strongly, with our powerful X-ray equipment, for some type I diamonds, that had the effect for type II diamonds been even 0·01 as intense it would almost certainly have been found.

(3) That the temperature-sensitive diffuse spots (primary extra reflexions) which are certainly due to X-ray diffraction by elastic vibrations, appear equally strongly for both types of diamond. Yet according to Raman[10] and Venkateswaran[11], the relative diffraction effect due to elastic vibrations should, on their theory, vary proportionately to the size of the crystal block, whereas that due to the excited characteristic vibrations should not.

(4) That soft organic crystals and soft metals such as sodium and lead, which are undoubtedly mosaic in structure, show excellent extra reflexions.

Pisharoty and Subramanian suggest that in the diamond orientation we used ($[1\bar{1}0]$ vertical), the [001] direction was tangential to the sphere of reflexion, thus accounting for the absence of extra reflexions along that direction for the (220) and (113) planes. A little consideration, however, shows that it was not. The [001] direction was more nearly normal to the sphere of reflexion than either [010] or [100] directions along which 220 extra reflexions *were* found, and only a little less so for the 113 reflexion. We thought it unnecessary in our former communications to stress the fact that the absence of extra reflexions along certain directions for some diamond planes is an intrinsic property of the diamonds and not an effect due to the geometry of the experiments.

Finally, we wish to point out, as an experimental fact proved beyond question[6], that the integrated intensity of a Bragg reflexion is *not* proportional to N^2 (N = number of lattice cells *in the crystal*) as Raman repeatedly implies[12], but to the volume of the crystal, that is, to N. Born's theory gives the integrated intensity of an extra reflexion as also proportional to N. In practice it is always integrated intensities that are compared.

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H. Smith.

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[1] Born, M., and Sarginson, K., *Proc. Roy. Soc.*, A, **179**, 69 (1941).
[2] Ott, H., *Ann. Phys. Leipzig*, **23**, 190 (1935).
[3] Raman, Sir C. V., *Proc. Ind. Acad. Sci.*, A, **14**, 340 (1941); *Curr. Sci.*, **10**, 474 (1941).
[4] Pisharoty, P. Rama, *Proc. Ind. Acad. Sci.*, A, **14**, 377 (1941).
[5] Lonsdale, K., *Proc. Roy. Soc.*, A, **179**, 315 (1942).
[6] Robinson, B. W., *Proc. Roy. Soc.*, A, **142**, 431 (1933).
[7] Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, A, **14**, 433 (1941).
[8] Pisharoty, P. Rama, and Subrahmanian, R. V., *Proc. Ind. Acad. Sci.*, A, **14**, 443 (1941).
[9] Lonsdale, K., and Smith, H., Nature, **148**, 112, 257 (1941).
[10] Raman, Sir C. V., *Proc. Ind. Acad. Sci.*, A, **14**, 330, 341, 372 (1941).
[11] Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, A, **14**, 396, etc. (1941).
[12] Raman, Sir C. V., *Proc. Roy. Soc.*, A, **179**, 309 (1942).

OBITUARIES

Dr. George Senter

The death of Dr. George Senter on March 14 brings to a close an eventful life as man of science and administrator. Let us recall the main events of his history. Born in 1874 at Kildrummy, Aberdeenshire, he was educated at the Universities of London, Leipzig and Göttingen. He obtained his first teaching post in 1904 as lecturer on chemistry at St. Mary's Hospital Medical School, and became head of the Chemistry Department, Birkbeck College, London, in 1913. Five years later, when the outcome of the War of 1914–18 was in the balance, Senter became principal of the College and so inaugurated a period which must be regarded as one of the most important in the history of that institution.

Birkbeck College grew out of the London Mechanics' Institution—founded in 1823 with Dr. George Birkbeck as first president. The College still maintains the honourable and ancient association of poverty and scholarship in that it serves the student who has to pursue learning and earn his living at the same time. Senter was the type of administrator who sees possibilities rather than difficulties and dangers. He grasped boldly and imaginatively the opportunities before him, with the result that when he retired in 1939 the College had become a school of the University of London, and on a fine site in Bloomsbury, next to the Senate House of the University, the foundations of a new college building were laid. Senter had good cause for happiness in the outstanding success of his principalship. Besides guiding the internal affairs of the College, Senter took a prominent part in the larger world of the University. As an active member of the Senate his shrewd judgment was appreciated and his work on committees and boards earned him the respect and affection of his colleagues.

George Senter possessed one of the rarest and most precious of gifts in a man of science or administrator —the gift of lucid exposition. This he turned to good account in his well-known books, "Outlines of Physical Chemistry" and "Text-book of Inorganic Chemistry," which have delighted and helped a generation of chemists. In view of his fine record in administration there may be a tendency to forget his eminence as a man of science. Senter realized at an early date that kinetic investigations would be necessary for the satisfactory elucidation of the problems connected with the phenomenon of the Walden inversion. He carried out a number of pioneer investigations and had he been able to devote himself to this work there seems little doubt that results of great theoretical interest would have emerged. Actually this early work on chemical kinetics in which he was engaged when he became principal of Birkbeck College is now regarded as fundamental, and after some twenty years forms the basis of one of the most rapidly developing branches of physical chemistry.

Although Senter was a bachelor he was not a self-centred man. He had a true and understanding heart associated with a tolerant mind and a happy gift of humour. For relaxation he turned to the peace and joy of his garden and the countryside. In the minds of the hosts of his friends there will ever remain the remembrance of a shrewd and kindly man who had a sincere desire to serve his fellow-men.

W. Wardlaw.

Dr. J. G. Myers

John Golding Myers was born near Rugby in Warwickshire on October 22, 1897. In 1911 his parents moved to New Zealand. There he did brilliantly at school, winning a scholarship to Victoria University College, Wellington. During the War of 1914–18 he came to Europe with the New Zealand Expeditionary Force. Returning to Wellington he completed his studies and obtained the B.Sc. and M.Sc. degrees.

From 1919 until 1924 Myers was employed as entomologist in the Biological Division of the New Zealand Department of Agriculture, where he did excellent work on the cattle tick and other pests. In 1924 he won the coveted honour of an 1851 Exhibition Scholarship for New Zealand and elected to go to Harvard University. There he worked at the entomological laboratory of the Bussey Institution, eventually obtaining the degree of Sc.D. In 1925 Myers came to England to represent the New Zealand Government at the Second Imperial Entomological Conference. Afterwards he went to France at the request of his Government to study the natural enemies of the pear leaf-curling midge. In the following year he was appointed to the staff of the Imperial Institute of Entomology to organize the breeding of parasites of injurious insects for export to the Dominions and Colonies. He did splendid work on the parasites of the blow-fly and of the timber-infesting wood-wasps, which made possible their export to Australia and New Zealand. Myers next visited Australia to investigate the passage of dried fruit from the vine to the consumer and was successful in tracing the sources of insect infestation. In 1928 he went to Trinidad to study the possibilities of the biological control of sugar cane pests. He travelled all over the West Indies and to Guiana and Surinam in search of parasites, and his report, published by the Empire Marketing Board, is a mine of information not only on insect pests and their parasites but also on the general ecology and agriculture of the countries visited.

Myers' work in the West Indies continued up to 1934, when he joined the staff of the Imperial College of Tropical Agriculture in Trinidad. Here he undertook a number of private expeditions at the request of various planters, collecting and studying the ecology of insect pests in unknown parts of British Guiana, Venezuela and Brazil.

In 1937 Myers was appointed economic botanist to the Government of the Anglo-Egyptian Sudan, his task being to survey the economic possibilities of the southernmost province of Equatoria with a view to its future agricultural development. Only preliminary reports of this work are available, but they cover a great variety of subjects and show the usual thoroughness of his approach and the broadness of his vision. It was fated that this task should not be completed, for he was killed in a motor accident near Amadi, Equatoria Province, on February 3.

Apart from his many papers on biological control, and related topics, Myers produced a large number of works on Hemipterous insects which showed him to be a morphologist and systematist of the highest order. Myers' versatility, broad ecological outlook and great experience in many parts of the world made him the most outstanding economic entomologist of his generation. In his death at the early age of forty-four, applied biological science has lost one of its most brilliant investigators. He leaves a widow and two small daughters in British Guiana.

W. E. China.

Sir William Bragg

Qu'il me soit permis d'apporter un hommage français à la mémoire de Sir William Bragg, dont la mort, suivant de près celle de J. J. Thomson, endeuille aujourd'hui la science anglaise.

J'avais appris à connaître et à admirer l'œuvre de Sir William Bragg, il y a de nombreuses années, alors que je faisais mes premières armes de chercheur au laboratoire de Madame Curie. Son livre sur la Radioactivité avait une place d'honneur dans notre bibliothèque, et le volume, très usé, témoignait de l'utilité de l'ouvrage : il était toujours entre les mains de quelque chercheur ou de quelque étudiant.

J'ai eu l'honneur d'être reçu par Sir William Bragg lorsque je parvins en Grande Bretagne après m'être évadé de France, en juin 1940. Je n'oublierai jamais l'amabilité de son accueil, ni les paroles de sympathie, si directes et si profondément senties, qu'il prononça à l'égard de notre malheureux pays.

Je suis sûr d'être l'interprète de tous les hommes de science français, forcés au silence par leur situation, en priant Sir Lawrence Bragg et la Royal Society d'accepter leurs condoléances émues et le témoignage de leur profond attachement à la mémoire du grand disparu.

A Free French Scientist.

NEWS and VIEWS

Gardiner Chair of Chemistry at Glasgow

After a connexion of almost forty years with the chemical department of the University of Glasgow, Prof. T. S. Patterson retires from the Gardiner chair of chemistry at the end of the present session, thus bringing to a close a period of teaching activity which has coincided with a period of great expansion in the University Chemical Department. As a research worker Prof. Patterson's chief interest lay in the subject of optical activity, and more especially in the physico-chemical aspect of the subject. His investigations on the effect of solvent, temperature and wave-length of light on the rotatory power of the derivatives of tartaric acid have produced data which will be of great value to future workers, while his modification of the "characteristic diagram" of Armstrong and Walker has simplified the co-ordination of rotatory dispersion phenomena. But in recent years Prof. Patterson has become more absorbed in the historical aspect of chemistry, and in this field he has found fuller scope for his literary ability than was possible in the mere recording of the results of personal experiment. The results of his researches on the lives and work of the earlier chemists have been embodied in excellent articles contributed to the *Annals of Science* and to *Isis*. He has always taken an interest in student activities and was a constant attendant at meetings of the "Alchemists", a student chemical society the well-being of which he had much at heart.

Dr. J. Monteath Robertson has been appointed to the Gardiner chair of chemistry in the University of Glasgow as from October 1, 1942, in succession to Prof. T. S. Patterson, whose resignation takes effect then. Dr. Robertson, who is forty-one years of age, was educated at Perth Academy and the University of Glasgow, where he graduated B.Sc. with special distinction in chemistry in 1923 and M.A. in 1925. His post-graduate research work also began there, and he has since received the degrees of Ph.D. and D.Sc. from the University. During the tenure of a Carnegie research fellowship Dr. Robertson worked at the Royal Institution in London under Sir William Bragg. During 1928–30 he was in the United States as a Commonwealth Fund fellow and worked in the University of Michigan and the Gates Chemical Laboratory, Pasadena. On his return he joined the staff of the Davy Faraday Laboratory of the Royal Institution and remained there until his appointment in 1938 as senior lecturer in physical chemistry in the University of Sheffield. He has published many papers dealing with the chemistry of natural products, X-ray diffraction methods, molecular dimensions and structure, etc.

Dr. Robertson is best known for his beautifully finished determinations of the structures of conjugated organic compounds by the X-ray study of minute single crystals. In 1932 he mapped the electron density distribution in anthracene crystals by means of two-dimensional Fourier analyses along three principal directions, and showed that the chemist's structural formula represents with considerable nicety the arrangement of atoms in the plane molecule. By designing an apparatus which would enable an absolute comparison to be made photographically between the intensities of the incident and reflected X-ray beams, and by devising various mechanical methods of speeding up the formidable amount of computational work involved, he was able to make similar studies of many other compounds, including those of the dibenzyl and the phthalocyanine series (partly in collaboration with Miss I. Woodward). He proved that the interatomic distances in these compounds are dependent upon the bond characters, and provided a mass of reliable experimental data for testing theoretical calculations based upon energy relationships. His direct determination of the structures of nickel and platinum phthalocyanines not only gave valuable information concerning the stereochemistry of those metals but also showed that the usual 'trial and error' method of determining phase constants can be dispensed with in special cases. His latest work (in collaboration with Dr. A. R. Ubbelohde) has concerned the lengths of hydrogen and hydroxyl bonds and their changes with crystalline dimorphism, temperature and deuterium substitution. Few present-day scientific men have succeeded in obtaining so much accurate numerical data of fundamental importance to organic chemistry.

Suppression of Culture in Norway

We are informed that a petition, signed by fifty-two members of the Royal Society of Science and Letters of Göteborg, has been presented to the Swedish Minister for Foreign Affairs asking him to intervene on behalf of three Norwegian members of the Society who have been imprisoned and subjected to severe treatment in Norway. A translation of the petition reads: "Three foreign members of the Royal Society of Science and Letters of Göteborg have already for a considerable time been deprived of their liberty. They are known to us as eminent scientists and scholars and are citizens beyond reproach. As far as we know, none of them has been convicted of any crime against the laws of their country by a legal court of justice or even accused of any criminal offence. To all of us their fate has given great pain. The fact that Prof. Seip (of the University of Oslo), for reasons unknown to us, has been subjected to cruel treatment has further increased our anxiety on their behalf. We members of the Royal Society resident in Göteborg herewith apply to your Excellency to do everything in your power in order to set our fellow-members at liberty and enable them to resume their studies and research." It is to be feared that this petition will be of little avail, though it reflects the views of the men of science of neutral countries, and is much to their credit.

Scientific Research in Sweden

Extensive research activity is going on in Sweden, in order to find substitutes for products which can no longer be imported owing to the War. One of the most important centres for this research is the Physical-Chemical Institute, Uppsala, headed by Prof. The Svedberg. The Institute has now lost all the foreign research workers who used to study there, with the exception of one Swiss; nevertheless the staff has been doubled. Extensions have in particular been made to departments dealing with the many present supply problems, of which the chemical aspects fall within Prof. Svedberg's own department, namely, the giant molecules. The work with different kinds of synthetic rosins and cellulose-derivatives is now progressing on a large scale. Among other objects of research may be mentioned bread. Experiments are being made to find a means of replacing imported hard wheat, which was formerly used to improve the baking qualities of bread made from Swedish native soft wheat. Investigations are also being carried out on synthetic rubber. The work has proceeded so far that the product has been evolved in the laboratories of the Institute, although it is too early yet to say whether domestic production can be started and its probable extent.

One of the foremost technical means of research of this Institute is the Svedberg ultra-centrifuge, which has become of the utmost importance to science. The rotor of this centrifuge is given a speed of up to 70,000 revolutions per minute by a number of oil turbines. The Institute also houses such instruments for research as one of the world's largest electro-magnets and a neutron generator, both of which have been made in Sweden. In the biochemical section the experiments for locating and cultivating infantile paralysis virus and tuberculine on the basis of a new method for analysing mixtures through molecule splitting are carried on under the direction of Prof. Arne Tiselius, who has devised this method. The object in the first place is to obtain a pure form of virus. The stoppage of the import of apes for these experiments for a while threatened the workers with the loss of indispensable test animals, but it is stated that their replacement with rats has now proved acceptable.

Quality Control in Manufacture

AN article by H. Rissik on "Quality Control in Manufacture" in the *Electrician* of March 27 reviews the principles of the subject with special reference to the use of control charts. The theoretical foundations of the method were laid down originally by Prof. R. A. Fisher, and the technique itself, which was originated in the Bell Telephone Laboratories of the United States, has been applied successfully for more than twelve years throughout the various manufacturing organizations of the Bell system. The technique of quality control is, briefly, one of inspection-cum-production, based on known statistical methods which have been applied successfully in other fields, and it has proved to be a valuable aid to manufacturing concerns engaged on repetition work. Its advantages include reduction in inspection costs and in rejects, attainment of maximum benefits from quantity production and of uniform product quality even though the inspection test be destructive, immediate applicability as part of inspection routine, and utter simplicity of application.

Fundamentally, the problem is one of controlling variability in some directly measurable quality characteristic, for example, dimension, weight, tensile strength, electrical resistance, hardness, etc. In practice this means analysing the variability observed and comparing it with some objective standard. Thus, provided a product is known beforehand to be stable, limits may be assigned within which practically all observed values of the variable quality characteristic are expected to lie. If measurements on a succession of piece-parts, produced supposedly under the same essential conditions, are found to give dimensional values lying outside these limits, then it may be inferred that they were not, in fact, so produced, that is, the production process was not stable in the first place. This leads to the very heart of quality control as a technique enabling preventive action to be taken before trouble develops; and the basis of this is the so-called quality control chart which is, in effect, a continuous graphical record of product quality. The article discusses the use of the control chart and makes reference to the recent British Standards Institution publications, *B.S.* 600–1942 and *B.S.* 1008–1942.

Electrical Instruments

IN his chairman's address to the Meter and Instrument Section of the Institution of Electrical Engineers (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 13, January, 1942), W. Phillips surveys the design and performance of electrical instruments. Development since the 1890's has been twofold: first in widening the limits of measurement, and secondly in accuracy. Switchboard moving-coil instruments are now available to give full-scale deflection for 10 μ amp. or less, and ammeters having a range of 30,000 amp. are in use. In voltage, the range is from a few micro-volts, with apparently no upper limit, the sensitivity of D.C. moving-coil instruments now being limited only by the non-magnetic quality of the moving system. The standardization of frequency at 50 c./s., and its close regulation by supply undertakings, has fostered the design and use of testing apparatus for the measurement of power factor, peak factor, and current; and also of voltage testing sets and similar apparatus for use at fixed frequency. The Electricity Supply (Meters) Act created an immediate demand for standard and sub-standard instruments of all types, large sums being expended by supply authorities in equipping meter-testing stations. Great improvements in wattmeter performance have been made, particularly in the reduction of self-heating error and D.C./A.C. change-over error.

One of the recent major troubles with which instrument makers have had to cope is the almost complete stoppage of supplies of sapphire jewels. An English company now manufactures sapphire jewels from rough boules, but it cannot yet meet the demand. Substitutes are being provided, consisting of nitralloy steel jewels for meters, while for instruments a specially hard glass jewel is available requiring no expensive or elaborate manufacturing plant. The jewels at present being manufactured are mainly for use in miniature instruments, a small number only having been made for larger instruments.

Electric Heating of Premises

MR. W. GILCHRIST, in a paper read recently before the Institution of Electrical Engineers on the above subject, deals with the various methods of applying electricity to space-heating, water-heating and sundry special applications with particular reference to large-scale space- and water-heating installations. The author records the fundamental principles of design and some of the results obtained from certain methods of heat application which do not, in some respects, follow existing practice. The possible economic limits of using electricity for direct heating are related to the capacity of both commercial and domestic buildings, there being a definite limit to the size of such installations both from the consumer's and supplier's points of view. Details are given of certain combinations of radiant and convection heating to achieve maximum comfort conditions at a lower cost to consumer and supplier than other existing methods. Examples are given of installations using a combination of thermal storage, local thermal storage and direct heating, and a method of applying water-heating to large installations is described which considerably improves the overall efficiency. A domestic electrification policy is outlined with special reference to space- and water-heating for working-class houses, and it is suggested that future policy in the domestic electrification of houses should be based on the use of a proportion of solid fuel for heating and water-heating.

Bee-keeping in War-time

At a lunch of the Backs to the Land Club held on March 25, Dr. C. G. Butler, of the Rothamsted Experimental Station, gave an address on the place of bee-keeping in the national economy. As Dr. Butler pointed out, it appears to be the common idea that the value of the honey-bee lies in the honey it produces. From the point of view of national economy, however, its function as the pollinator for fruit and seed crops is of prime importance. Honey has not been found to contain any measurable quantity of vitamins, but its invert sugars make it very readily assimilated by the human body. It is therefore of special value in treating cases of shock; also invalids and young children. Dr. Butler stressed the undesirability of too many beginners taking up bee-keeping at the present time. The shortage of supplies, in his opinion, is such that established bee-keepers should have first claim on such supplies, rather than the novice knowing nothing at all about bees. There is evidence that in many places where large orchards, or areas of insect-pollinated seed crops are planted, there are insufficient wild pollinating insects present for full production. Dr. Butler urges that, at the present time, greater efforts should be made to use honey-bees for pollination by making them available by the transfer of stocks to such areas where they are most needed.

Wilhelm August Lampadius (1772–1842)

At the time when geologists and mining students flocked to the Freiberg Mining Academy in Saxony, and when Gottlob Werner was at the height of his fame, a twenty-year-old chemist because a member of the staff, and from that time onwards for half a century, he taught, wrote and experimented with great success. This young chemist was Wilhelm August Lampadius, who in his fourteenth year had been apprenticed to a Göttingen apothecary. Born at Hehlen in Brunswick on August 8, 1772, Lampadius lost his father, a pastor, at an early age. Apprenticed by his mother at Göttingen he devoted his spare time to study and was befriended by the university professors J. F. Gmelin and Lichtenburg. At the age of nineteen he entered the service of the metallurgist Count Sternberg of Bohemia. With the Count he made a journey to Russia and in the Count's laboratory made experiments on electricity and heat. His talents becoming known to Werner, he was given a post at Freiberg and on the death of C. E. Gellert (1713–1795) he was made professor of chemistry. In this situation he assisted German industry in many ways. He spread a knowledge of Lavoisier's discoveries, and made researches connected with mining and metallurgy, chemical manufactures, agriculture and meteorology. Especially important among the books he published was his handbook on smelting. A man of estimable character, respected alike by his friends and colleagues, he died at Freiberg on April 13, 1842) in his seventieth year. His place in the Academy was taken by Karl Friedrich Plattner (1800–1858), the chief of the royal department of assaying and an authority on the use of the blow pipe.

Earthquakes Registered at Kew

During February 2–March 5 four large earthquakes were registered on the seismographs at Kew Observatory. The first, on February 2, began recording at 17h. 15m. 28s. U.T., possibly from an epicentral distance of 1,500 km., though long waves were not pronounced and the shock appeared to possess some of the deep-focus characteristics. On February 16 a strong shock began recording at 18h. 27m. 31s. U.T., possibly from an epicentral distance of 13,300 km. It finished recording at 20h. 00m., having lasted some 1h. 32·5m. The third earthquake, on February 21, began recording on all three components with *iP* compressional at 07h. 20m. 14s. The tentative calculated epicentral distance was 9,300 km. The shock appeared to be normal, had a maximum ground amplitude at Kew of 72 μ, and finished recording at 09h. 40m. U.T. The third disturbance, on March 5, began recording near 19h. 59m. 56s. U.T., though the start of *iP* was somewhat confused by microseisms. The epicentral distance may have been near 8,200 km., the long waves were of small amplitude, and the shock finished recording at 21h. 10m. U.T.

Announcements

On the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the James Alfred Ewing Medal for 1941 has been awarded to Dr. F. W. Lanchester. The Medal is awarded annually for specially meritorious contributions to the science of engineering in the field of research.

The first Sir Joseph J. Thomson Memorial Lecture of the Chemical Society will be given by Lord Rayleigh, in the Lecture Theatre of the Royal Institution on April 16 at 4.30 p.m.

Prof. B. K. Malinowski, University professor of anthropology in the London School of Economics who now holds the position of Bishop Museum visiting professor of anthropology in Yale University, has been appointed professor of cultural anthropology at that University as from July 1.

Prof. Emil Abderhalden, professor of physiology at Halle and for many years president of the German Academy of Natural Sciences at Halle, has had the latter appointment extended for another ten years.

At a meeting of the Quekett Microscopical Club, held on March 21, the following officers were elected: *President*, Mr. W. E. Watson Baker; *Hon. Librarian*, Mr. C. Best; *Hon. Curator*, Mr. C. Sidwell; *Hon. Secretary*, Miss C. Arnold.

The following awards in respect of the year 1941 were made at the annual corporate meeting of the Institution of Chemical Engineers on March 27. The Osborne Reynolds Medal, for meritorious work accomplished for the advancement of the Institution during the year, to Dr. A. Parker, honorary editor and recorder of the Institution; the Moulton Medal (in gold), for the best chemical engineering paper of the year, of a mature character, read before the Institution and published in the *Transactions*, to Mr. P. Parrish, for his paper "Modern Developments in the Design of Plant for the Concentration of Sulphuric Acid"; the Junior Moulton Medal for 1941 was not awarded; the William Macnab Medal, for the best set of answers submitted in the associate-membership examination during the year, to Mr. E. W. Pates.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Use of Soil Fertilizers in China

Beginning in 1935, this Department has been investigating the fertility of the soils of China, with especial reference to the limiting effect of plant food deficiencies, and to the possibility of increasing crop production by the use of fertilizers. The investigation is based in the first place on field experiments, chiefly 'NPK tests', consisting of modern factorial designs at two and/or three levels. The standard rate of application throughout is eight *catties* per *mou* (about 0·5 cwt. per acre) of nitrogen, phosphate and potassium (N, P_2O_5, and K_2O). The experimental crops are rice, wheat, maize, rape-seed, cotton, millet, barley, sugar cane, Irish and sweet potatoes, and mulberries (chiefly the first five). The experiments have been carried out either by this Department directly, or in co-operation with provincial institutes, universities, and other organizations. The field experiments are supplemented by laboratory chemical tests for 'available' nutrients in the soils of the experiments.

The results of more than 170 of these field experiments, widely scattered through fourteen provinces of China, are now available. The work is still continuing, and yield results already obtained are still being analysed, but although the investigation is thus incomplete, it is desired to put the broad results on record, in case the work should be interrupted. It is realized that the number of experiments is not large, in relation to the area covered (a consequence of the difficult conditions which have existed here since 1937), but none the less the general results are quite consistent within the various regions or soil groups, and it is believed that further extension of the work will not greatly alter the picture. It is thought that the findings will have some general interest to agriculturists and geographers, while the implications are important for the future of China.

Eighty-three per cent of the soils tested in the field experiments gave significant responses to one or more nutrients: in other words, soil fertility is likely to be limited by plant food deficiencies in at least four fifths of the soils of China. (Early statements about the high fertility of Chinese soils were usually based on a superficial acquaintance with the rich soils of alluvial plains and deltas; much of interior China consists of relatively poor, hilly, land.) Nitrogen deficiency was most general (74 per cent of the soils); next came phosphate deficiency (38 per cent); potash deficiency was uncommon (12 per cent), probably because of the general use of ashes and local manures. There were clear relationships between the great soil groups and nutrient supply or deficiency, which there is not space here to set out in detail. Briefly, the pedocal soils of north China (J. L. Buck's 'wheat region') were often deficient in nitrogen, but they were generally well supplied with phosphate and potash; the pedalfer soils of central and south China (Buck's 'rice region') were still more deficient in nitrogen, often seriously deficient in phosphate, and sometimes deficient in potash. The red and yellow earths were the most seriously nutrient-deficient soil groups, and those on which fertilizers were most strikingly effective in increasing yields.

Estimates were made of the probable extent to which crop production could be increased in China by using artificial fertilizers in addition to the present supplies of local manures and fertilizers (which cannot be much expanded). If artificial fertilizers were used only on soils where they were likely to be needed (on the soils which gave significant responses in these experiments), it would be possible to increase the total production of crops in China by between one third and one half, using the rates of application mentioned above. (The variability of the estimate depends on the weights to be applied to different crops and regions.) This estimate may be taken as applying to the part of China covered by Buck's "Land Utilization in China", with the exclusion of his 'spring wheat area'. The increase in production would be much greater in the rice region (about one half increase over present production) than in the wheat region (about one fifth increase).

Taking economic factors into consideration, and using the 1937 farm prices in east and north China as a basis, it can be said that if all farmers whose soils needed fertilizers applied what was necessary, at the standard rate, then on the average individual farmers would have a two-to-one chance of making a profit (that is, one farmer out of three would be likely to lose money). If only those farmers applied fertilizers whose soils were likely to give an economic response, on the basis of the field experiments, total crop production in China could still be increased by at least one quarter. Supposing that China developed her own fertilizer industry, and that fertilizers could be sold at prices comparable with those in the United States in 1937, then these estimates would be considerably increased. If all farmers with deficient soils used the necessary fertilizers, then each farmer would have at least a five-to-one chance of making a profit from his expenditure; if only those farmers used fertilizers who were likely to secure an economic response, total crop production in China could be increased by at least one third.

The bearing of these results on the population, food and economic problems of China needs no emphasis. While it may not be possible to take much action on them under present conditions, for the future they are equivalent in increased production to adding four or five new provinces to the seventeen or eighteen provinces for which these estimates may be expected to hold good. In connexion with the reclamation and resettlement of the poor soils of south-west China, too, the use of fertilizers is likely often to make the difference between success and failure.

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Age Changes in Size of Muscle Fibres of the Marsupial Heart

As we have pointed out elsewhere[1], there is considerable evidence for believing that the conducting systems of mammalian and avian hearts (nodes and Purkinje fibres) are neomorphic developments, evolved in response to functional requirements in these homoiothermal vertebrates, and not remnants of more extensive tissue of similar structure in lower vertebrate hearts[2,3] or embryonic muscle[4,5].

We have hitherto based our conclusions on histological studies of the hearts of lower vertebrates, in which we have failed to find any nodal or Purkinje tissue. We have now striking corroboration that these tissues are specialized structures and not embryonic remnants from measurements of the fibre-size of various regions of marsupial hearts, *Macropus ruficollis bennetti*, fœtus (pouch state) and adult, and adult *Macropus giganteus*. The accompanying table shows the maximum breadth of the majority of fibres in each region; a small range of variation in size of fibre occurs in each case, but this is in no way comparable in magnitude with those differences between the specialized and ordinary heart muscle to which we have directed attention.

	M. ruficollis (fœtal stage) Fixed—10 per cent formalin. Stain—Van Gieson and iron hæmatoxylin	*M. ruficollis* (adult) Fixed—10 per cent formalin. Stain—Van Gieson and iron hæmatoxylin	*M. giganteus* (adult) Fixed—10 per cent formalin. Stain—Pyridine silver
Sinu-atrial node	8 μ	(Sinu-atrial node not present in block)	10 μ
Atrio-ventricular node	10 μ	10 μ	10 μ
Atrio-ventricular bundle (Bundle of His)	12 μ	36 μ	36 μ
Atria	4 μ	11 μ	16 μ
Ventricles	5 μ	12 μ	18 μ

It will be observed that, whereas the ordinary trial and ventricular muscle fibres increase markedly n size from the fœtal to the adult stage, the nodal ibres are fully developed in the fœtal stage. This uggests strongly that the nodal fibres are specially eveloped (for the initiation of the cardiac rhythm), hile the size of the ordinary heart muscle increases ith the increasing work (against peripheral resistnce) which this muscle is called on to perform. The odal fibres in the fœtus are larger than the ordinary trial and ventricular fibres, a condition which is eversed in the adult. This suggests that the nodal ibres do not constitute an embryonic stage in the evelopment of ordinary myocardium but attain full pecialization for their particular function early in fe. The large increase in size of the Purkinje fibres ith age can be correlated with the requirement for ore rapid conduction of the impulse in the larger eart.

A full account of the conducting systems of these nteresting hearts will be published elsewhere.

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avies, F., and Francis, E. T. B., *Phil. Trans. Roy. Soc.*, B, **231**, 99 (1941).
eith, A., and Flack, M., *J. Anat.*, **41**, 172 (1907).
ackenzie, I., *Int. Cong. Med.* Sect., **3**, 121 (1913).
askell, W., *J. Physiol.*, **4**, 43 (1883).
is, W., jun., *Arb. med. Klin. Lpz.*, 14–49 (1893).

Extra Spots in Electron Diffraction Patterns

Many photographs have recently been published showing extra spots in X-ray diffraction patterns from single crystals. These extra diffractions are ascribed to thermal vibrations of the atoms or molecules in the crystal; they are close to the normal Laue-spot positions and comparable in size with the Laue spots. The close parallelism between the electron and X-ray diffraction phenomena leads us to expect that diffractions of this kind should also occur in electron-diffraction patterns, but although we observed[1] much more diffuse maxima two years before the work of Preston[2] directed attention to the X-ray extra spots, no extra spots of the X-ray type have hitherto been observed in electron diffraction, nor has the diffuse electron type been observed in X-ray patterns. It therefore appeared desirable to discover whether this distinction was of fundamental importance, or simply due to the difference in experimental conditions so far adopted. The absence of the diffuse electron type of maxima in X-ray patterns is apparently due to the experimental conditions[3], but we were unable to explain the lack of such extra spots in electron diffraction.

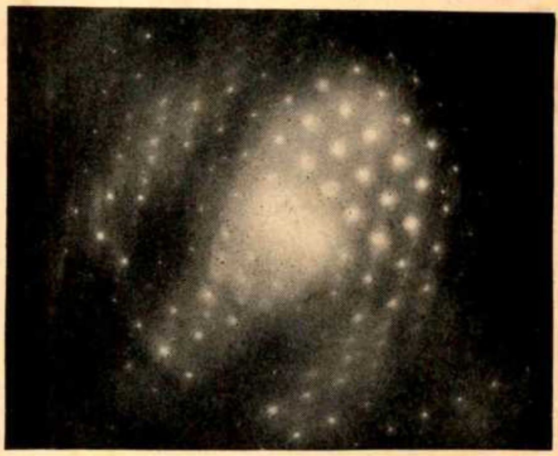

Fig. 1.

ANTHRACENE, SHOWING SHARP LAUE SPOTS, DIFFUSE, SLIGHTLY ELONGATED, EXTRA SPOTS AND DIFFUSE BANDS.

The recent clarification of the X-ray results has led us to re-examine some electron-diffraction patterns in which we had noticed apparently anomalous features. These we now find correspond closely to the X-ray extra spots. Thus, diffuse spots occur in regions where the sharper Laue spots are forbidden, as may be seen clearly in Fig. 1, obtained from anthracene with the electron beam practically parallel to [112]. The diffuse spots correspond to intersections of the sphere of reflexion with the reciprocal-lattice intensity regions, which are enlarged as a result of thermal vibrations in the crystal.

In very anisotropic crystals the intensity regions may become elongated in characteristic directions, and with suitable crystal orientations they may give rise to streaks in the diffraction pattern[4]. In the case of anthracene we have found in many patterns, including several published previously[1], a series of such streaks, the positions and directions of which indicate that the molecules vibrate with maximum amplitude at right angles to their length (Fig. 2).

We have also observed these phenomena in other aromatic compounds, as well as in long-chain hydrocarbons and their derivatives. We therefore conclude that the parallelism between the electron and X-ray diffraction phenomena also extends generally to the effects originating from thermal vibrations in crystals.

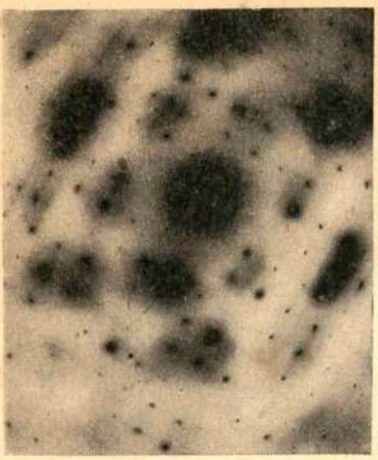

Fig. 2.
ANTHRACENE, SHOWING LAUE SPOT PATTERN, DIFFUSE MAXIMA AND EXTRA DIFFRACTIONS ELONGATED NORMAL TO THE LONG AXIS OF THE MOLECULE.

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[1] Finch, G. I., and Wilman, H., *Ergebn. exakt. Naturwiss.*, **16**, 353 1937); Charlesby, A., Finch, G. I., and Wilman, H., *Proc. Phys Soc.*, **51**, 479 (1939).

[2] Preston, G. D., *Proc. Roy. Soc.*, A, **172**, 116 (1939).

[3] Charlesby, A., note to be published.

[4] Lonsdale, K., Robertson, J. M., and Woodward, I., *Proc. Roy. Soc.*, A, **178**, 43 (1941). Lonsdale, K., and Smith, H., *Proc. Roy. Soc.*, A, **179**, 8 (1941).

Open Packing of Spheres

AT the present time when economy of material is so important, the problem of the open packing of spheres possesses more than theoretical interest. The most open (or least dense) packing is unknown[1]. A number of systems have been described by Heesch and Laves[2] including one with a density of 0·056, which may well be the most open possible under the conditions which they have imposed upon themselves. But if the object be to obtain a homogeneous structure with minimum density, in which each sphere makes contact with three others, and which shall be in equilibrium (though not necessarily in stable equilibrium), then, discarding the condition that the assemblage shall be of the single-parameter type, it is possible to proceed as follows:

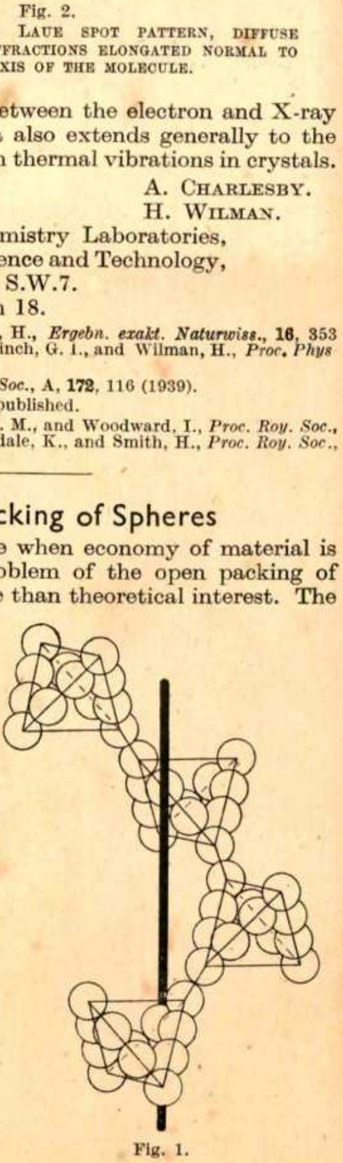

Fig. 1.

Take twelve equal spheres and arrange them in contact with their centres on four opposite edges of a regular tetrahedron. Take quantities of such tetrahedra and arrange them about a tetragonal screw-axis in such a way that a face of a tetrahedron is co-planar with a face of each adjacent tetrahedron, a plane of symmetry perpendicular to these faces being common to the two adjacent tetrahedra (Fig. 1). By extending the process systematically a series of tetragonal screws is developed, alternately right- and left-handed. Part of this tetragonal assemblage as seen from above is shown in Fig. 2. It has a density of 0·042.

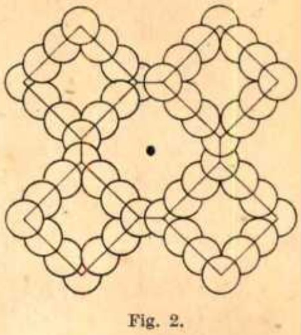

Fig. 2.

The study of a model of the lines of centres of the spheres in this structure, considered as a system of girders, may perhaps commend itself to engineers.

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[1] Nowacki, W., "Homogene Raumteilung und Kristallstruktur", p. 4 (1935).

[2] Heesch, H., and Laves, F., *Z. Krist.*, **85**, 443 (1933).

'Firmness' in Compression and Tension

ATTENTION was directed some time ago[1] to th applicability of Scott-Blair's equation, $\psi = s^{\beta}\sigma^{-1}t$ (s is shearing stress, σ is strain, t is time, ψ is firmness k and β are constants) for the 'firmness' of sof materials[2] to tests in tension as well as to tests i compression. This applicability was later extende to tests in torsion[3]. Some actual experimenta figures were published showing the comparison between tension and torsion tests results, but no figure have been given for comparative tension and compression tests. These were omitted as no good agreemen was obtained, apparently indicating the existence o experimental errors. It is now believed, howeve that the apparent anomalies are due to a fundament cause and not to experimental error.

		Bitumen 2	Bitumen 4	Bitumen
k:	extension	0·47	0·82	0·89
	compression ...	—	0·70	0·74
	torsion	0·48	0·85	0·82
log ψ:	extension	8·0	6·3	7·1
	compression ...	—	6·2	6·6
	torsion	7·9	6·6	6·9

A few typical results are given in the accompanyi table, whence it is seen that the values for both and log ψ are higher for tests in tension than compression. Torsion tests give values not precise corresponding with either of the other two methods, but approximating to the tension figures. They are definitely higher than the compression figures.

It has been suggested[4] that the differences may be eradicated by making allowance for the changing cross-sectional area of the specimen during test in the case of the extension tests, as this factor was ignored during early experiments and is automatically counteracted in the particular compression apparatus employed. Such correction may be made in tension experiments by calculating the strain on the extended length of the specimen.

Alternatively, where β is not unity, the correction may be made by using the equation :

$$\log\log\frac{l}{l_0} - \beta\log\frac{l}{l_0} = \beta\log s_0 - \log\psi + k\log t,$$

where s_0 is initial value of stress, and l_0 and l are initial and final lengths of the specimen.

Such correction does not, however, entirely account for the anomalies, and it is suggested that the difference is a fundamental one possibly due to the effect of the inter-molecular forces of attraction and repulsion.

The situation with respect to such factors is very complex and will be affected by the physico-chemical as well as the chemical constitution of the material under test. Thus the shape of the molecules, their orientation, their degree of association and their existence in the form of colloidal micelles will all nfluence the behaviour of the specimen under different types of deformation. General consideration of these inter-molecular forces would lead us to expect a decrease in ψ and k with increasing stress. This decrease is, in fact, found when a single method of est is employed (for example, either extension or compression). That a comparison of results by the wo methods does not fall into this scheme may be due to the fact that in calculating ψ and k certain simplifying assumptions have been made which are not true. In particular, it may be that with these particular materials Poisson's ratio is not 0 : 5 as ad been supposed.

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Broome and Bilmes, Nature, **147**, 176 (1941).

Scott Blair and Coppen, *Proc. Roy. Soc.*, B, **128**, 109 (1939).

Broome and Bilmes, *J. Soc. Chem. Ind.*, **60**, 184 (1941).

Lethersich, W., private comm. 1942.

Silica and the Liesegang Phenomenon

The synthesis of a wide range of rhythmic strucures, their relationship to naturally occurring forms nd the physico-chemical basis common to them have ready been studied by one of us (M. C.)[1]. The eliminary experiments outlined in the present note xtend the application of the Liesegang phenomenon silica and its hydrates.

Test-tube experiments with aqueous solutions of mmercial waterglass (1 : 1 by volume) carefully vered with an excess of concentrated hydrochloric cid at about 17° led to the immediate formation of fine network structure which soon became a anslucent membrane at the interface of the two liquids. Within 24 hours, 30 white horizontal bands were formed below the membrane. In the course of the next few days the number of bands had greatly increased—occupying more than 80 per cent of the original column of waterglass. The interband spaces increased as the reaction progressed, the 12 bands per cm. below the membrane gradually being reduced to 9 per cm. at the end of the reaction. On standing, the bands, laminated in structure, tended to arrange themselves in groups.

Experiments with more dilute waterglass (3 volumes of water to 1 of waterglass) led to interesting results. The progress of reaction was accelerated and the bands were found to be more closely packed (15 per cm.), aggregating into groups of about four. Above the membrane, in the region originally occupied by hydrochloric acid, a clear jelly-like mass was found (presumably silicic acid gel) equal in volume to about one third that of the waterglass. In some instances, however, the viscous matter exhibited distinct opalescence. Using concentrated waterglass the reaction is slower, the bands are fewer and thicker, being frequently connected by vertical columns of sodium chloride. This is especially the case when hydrogen chloride is the reagent.

In reactions where sulphur dioxide or sulphuric acid had been substituted for hydrochloric acid, certain anomalies were noted, influencing the pattern of depositions. The radial and network structures characterizing the initial stages of membrane- and laminæ-formation were superseded by, or rather modified into, concentric ring forms. With concentrated waterglass the interference to diffusion (probably due to the influence of specific colloid-electrolyte complexes) converted the regular pattern of the laminæ, as viewed from below, into walnut- and pomegranate-like surfaces. These transitions in the pattern development of the laminæ were well demonstrated in beaker and Petri dish experiments, membranes originating in all cases from the periphery of the surface. This dependence of the type of deposition upon the character of the accompanying electrolyte may be of considerable morphological significance.

The fact that the membrane at the interface of the two reacting liquids was at no time distorted by protuberances, particle eruptions or arboreal growth strongly suggests its colloidal character (compare reactions of transitory and permanent colloids as given in earlier publications). Under the experimental conditions used, there was no transition to anhydrous silica, the stratified precipitate remaining in a state of *limited* hydration. The relation of this state to the *unlimited* hydration of silicic acid gel is analogous to that found in the cases of soap curd – soap gel[2] and hydrocalcite – colloidal calcium carbonate[3].

It is intended to use these results as a basis for the synthesis of such minerals as itacolumite (by compression and subsequent dehydration with or without fluxes), opalite, hyalite, etc.

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[1] Copisarow, *J. Chem. Soc.*, **123**, 785 and 796 (1923); 222 (1927). *Koll. Z.*, **44**, 319 (1928); **47**, 60 (1929); **49**, 309 (1929); **54**, 257 (1931). Nature, **129**, 400 (1932). *J. Phys. Chem.*, **36**, 752 (1932). *Science*, **77**, 581 (1933). *Protoplasma*, **30**, 258 (1938).

[2] Laing and McBain, *J. Chem. Soc.*, **118**, 1506 (1920). Marton, McBain and Vold, *J. Amer. Chem. Soc.*, **63**, 1990 (1941).

[3] Copisarow, *J. Chem. Soc.*, **123**, 785 (1923).

RESEARCH ITEMS

Mammalian Arm Arteries

THE Field Museum of Natural History has published a volume of eleven papers in honour of Wilfred Hudson Osgood (Zool. Ser., 27; 1941). Osgood's name is well known to all workers in that subject as a first-class field naturalist and a sound and critical systematist. He joined the staff of the Museum in 1909, and during his term of office as chief curator of zoology that department has made extraordinary progress. The longest memoir in the volume is that by D. Dwight Davis on "The Arteries of the Forearm in Carnivores". The classical work of Zuckerkandl contains accounts of these vessels in sixteen species, but the present paper involved the dissection of thirty-five specimens carefully chosen so that twenty-five genera are represented. The information thus obtained, with that previously recorded, enables an extensive comparative survey to be made. The vessel pattern of the forearm furnishes evidence of the inter-generic and inter-family relationships, although some allowance has to be made for functional specializations. The most primitive pattern is to be found in the Hyænidæ, although they show certain cursorial adaptations. The Canidæ are also primitive but fundamentally different from the other Arctoidea. More investigation in the Viverridæ is required before definite conclusions can be drawn, but apparently they exhibit the least primitive pattern among the Aleuroidea.

Control of Cabbage Caterpillars

TECHNICAL BULLETIN No. 782 of the U.S. Department of Agriculture deals with the control of cabbage caterpillars by means of insecticides. The authors, W. J. Reid, jun., and collaborators, have carried out a large series of experiments specially designed to deal with outbreaks at the time when the crop is being harvested, when there is no opportunity for the natural removal of spray residues. Their recommendations, it may be added, are specially applicable to conditions in the south. They demonstrate that arsenicals should not be applied at any time on that portion of the plants which is to be marketed or consumed as food. The whole problem, therefore, was to discover satisfactory substitutes that would kill the pests concerned without leaving harmful residues. The insects involved were mainly the cabbage looper (*Autographa brassicæ*), the diamond-back moth (*Plutella maculipennis*) and the small cabbage white (*Pieris rapæ*). Practically all the experiments were made with materials used as dusts. Talc, china clay, sulphur, tobacco dust and lime were used as diluents for the insecticidal substances. It appears that derris dusts gave the most uniform performance, and a mixture containing 0·5–1 per cent of rotenone is sufficiently toxic to the three pests named to be of value as a substitute for arsenicals. All other treatments were relatively ineffective against larvæ of the diamond-back moth. In view of the frequent severe damage by cabbage white butterfly larvæ in Britain the results of these experiments are of importance on both sides of the Atlantic Ocean. The tests were made by means of rotary hand dust guns and in most cases were at the rate of 15–20 pounds per acre—the quantities being determined by weighing the dust guns before and after each application.

Salmon Gill Maggots

WHILE the presence of a parasite on the gills of the salmon was reported in Scotland so far back as 1766, and is well known to fishermen, its life-history has been worked out and recorded for the first time by G. F. Friend (*Trans. Roy. Soc. Edin.*, 60, Pt. 2; 1941). The salmon is notoriously difficult to keep in aquaria and so ordinary laboratory culture methods could only be applied to the development of the egg, and the rest of the life-history of the parasitic copepod, *Salmincola salmonea*, had to be followed by examining a large number of fish over a series of years. The author has added much to previous knowledge: the free-swimming larval stage, the attached male and female larvæ and several early stages of the female and the attached male (a rare form since only six were obtained to 4,000 females). A useful diagram of the life-history shows that infection takes place on or near the spawning bed after the return of the salmon from the sea, and so, *prior to spawning*, 'n fish was infected. The attached parasite can b carried out to sea and hence the subsequent returns o the salmon serve to spread the infection. The parasite, even when present in numbers up to a hundre on an individual fish, does not appear to harm it host directly but the wounds it makes on the gi filaments by stripping patches may provide point of ingress for pathogenic organisms.

Metasomatic Origin of Granophyre

A 500-FT. sill of dolerite occurring at Hangnest i the Cape Province of South Africa exemplifies ver clearly two well-marked features of the thicke Karroo sills: (*a*) very slight crystallization differentiation; and (*b*) marked tendency to react with an mobilize the associated sediments. A petrologica and chemical study of this sill and a discussion o the petrogenetic processes involved have been presented by F. Walker and A. Poldervaart (*Geol. Mag* 429; 1941). Thick bands of sediment were stope up from the floor and down from the roof and s became enclosed, together with numerous xenolith in the magma. The composition of the sediment was such that they easily underwent mobilizatio this being followed by rheomorphic injection int the dolerite, locally with sufficient force to brecciat the contact facies of the sill. Nearer the middle th rheomorphic veins reacted with the partly crystallize dolerite to form a richly micropegmatitic rock. large xenolithic block of siltstone was metasomaticall reconstituted by introductions of soda and sma amounts of the cafemic oxides, with production of granophyric rock of a type which is of widesprea occurrence in the Karroo petrographic provinc The occurrence recalls the transformation of t Caledonian granodiorite of Newry into granophy of Tertiary type at the contacts of the former wi Tertiary gabbro (D. L. Reynolds, *Proc. Geol. Asso* 265; 1937).

Auto-correlation of Meteorological Time Series

A PAPER by T. E. W. Schumann and W. Hofmeyer, entitled "The Problem of Auto-correlati of Meteorological Time Series, illustrated by Examp from South African Stations" was presented at *meeting of the* Royal Meteorological Society held February 18. The main object of the paper was present a number of characteristic values of t auto-correlation coefficient as actually comput from observed series of temperature and pressu For this purpose the temperature and pressu records of some South African stations were selected. In the case of temperatures, it was found that, provided any daily or seasonal fluctuations are first eliminated and the standard deviation is constant, the coefficient of auto-correlation R' has the analytic form $R'=e^{-ky}$, in which k is a constant and y is the time-lag. If, however, there is a marked variation in the standard deviation, such as is nearly always present in hourly values of temperature, R' is a function not only of the time-lag, but also of the actual times marking the beginning and end of the time-lag under consideration. In the case of a series of pressure readings, R' is not a simple exponential function, but may contain one or more damped harmonic terms.

High-Frequency Attenuation

AN improved D.C. substitution method of measuring high-frequency attenuation has been described by H. B. Noyes (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941). In the design of a wire communication system, attenuation data are practically indispensable, and measurements are often made by passing currents of various frequencies over a section of the line, and measuring the input and output with thermocouples, the accuracy obtained depending on the stability and accuracy of the thermocouples. Although this method is satisfactory on long lines, higher accuracy is sometimes needed, particularly when characteristics of short lines are to be determined. The D.C. substitution method has been found to give more precise results on attenuation measurements of this type and has the advantage of using the D.C. value of a resistance as a standard. The accuracy is practically independent of the calibration and stability of the thermocouple, which is used merely to relate the test-line attenuation to a value of an adjustable calibrated resistance in a D.C. circuit. The method requires, however, that either the D.C. and A.C. sensitivities of a thermocouple be identical, or the ratio between the D.C. and A.C. sensitivities of the sending and receiving thermocouples be identical. As a result of this refined technique, insertion losses at frequencies of 12–68 kc. could be determined with a reproducible accuracy or sensitivity of 0·005 db., a much higher precision than has hitherto been attained, contrasting with an error of 0·1–0·2 db. due to thermocouple errors of older methods.

Field Measurements of Insulation

A PAPER on the above subject presented recently by E. A. Burton, J. S. Forrest and T. R. Warren to the Institution of Electrical Engineers deals with the field testing of high-voltage switchgear, busbar and transformer insulation as a means of alleviating insulation failures in service, and describes the apparatus and methods employed by the authors on the Central Electricity Board system. The three main testing techniques, (*a*) measurement of power factor, (*b*) measurement of potential distribution and (*c*) measurement of insulation resistance, are described and practical testing apparatus, designed to make such measurements under the onerous conditions of field use, are described. Three wattmeter types of power-factor measuring apparatus are described, two for 10 kv. tests for bushing sets, and one operating at 50 kv. for tests on busbar systems. Details are given of a bridge specially developed for field testing, and the measurement of potential distribution on bushings in service is discussed, reference being made to an electronic testing set for the measurement of insulation resistance up to 10,000 megohms at 5 kv. The summarized results of more than two thousand tests on installed apparatus are given and special test methods are described to facilitate power-factor measurements on transformer bushings and orifice insulators. Information is also given on the power-factor of oil in service. Methods are suggested of continuously supervising the insulation of important installations in cases where the lower voltage end of the insulators can be isolated from earth, and finally, the merits and demerits of the three main test methods are summarized in order to assist the maintenance engineer in choosing the method or methods best suited to his requirements.

Surface Films of Lupane Derivatives

MANY sterols and triterpenes containing water-attracting groups form stable unimolecular films when spread on water or, in some cases, dilute acid or alkali. Sterols and triterpenes with hydroxyl groups at the extremities of their ring systems form almost incompressible films with limiting areas of 38–42 A.^{2} and 45–50 A.^{2}, respectively. P. Bilham, E. R. H. Jones and R. J. Meakins (*J. Chem. Soc.*, 761; 1941) have made surface-film measurements on a number of derivatives of the triterpene alcohol lupane, for which there is lack of information as to the positions of the hydroxyl and *iso*propenyl groups. The small limiting-area values found, particularly with bisnorlupanic acid and ψ-lupenol, and the large area values found with lupenediol and lupenetriol monoacetate, in conjunction with the chemical data found by Heilbron and others, furnish evidence that in lupeol the *iso*propenyl group is situated at the opposite extremity of the ring from the hydroxyl group. The curves for the pressure-area measurements on the films are shown and discussed in detail in the paper, which records an interesting application of a physico-chemical method in studying the structure of a complicated organic molecule.

Exchange Equilibria

IN a paper dealing with exchange and transfer equilibria in mixtures of solvents, R. W. Kingerley and V. K. La Mer (*J. Amer. Chem. Soc.*, 63, 3256; 1941) point out that, in a solvent consisting of protium oxide (H_2O) and deuterium oxide (D_2O), in a reaction of the type,

$$\tfrac{1}{2}H_2O + KOD(D_2O) + KBr(H_2O) = \tfrac{1}{2}D_2O + KOH(H_2O) + KBr(D_2O),$$

there is a free energy of exchange when potassium hydroxide is converted into potassium deuterate and also a free energy of transfer of potassium hydroxide and potassium bromide from one solvent to the other. The latter process has not always been correctly treated. In many cases the free energy of exchange is of minor importance. The equilibrium process formulated above was determined from analytical measurements of the process

$$\tfrac{1}{2}HgO + \tfrac{1}{2}Hg + \tfrac{1}{2}H_2O + KBr(H_2O) = \tfrac{1}{2}Hg_2Br_2 + KOH(H_2O)$$

in $H_2O - D_2O$ mixtures and was found to compare favourably with the value calculated indirectly. The solubilities of thallous chloride and calcium hydroxide were determined in the two waters and the exchange coefficient of the base measured in a sample of mixed solvent. The ion product constant of deuterium oxide was calculated indirectly as $1{\cdot}54 \times 10^{-15}$ at 25°, in good agreement with $1{\cdot}6 \times 10^{-15}$ reported by Abel, Bratu and Redlich in 1935.

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE first report of the National Institute of Economic and Social Research, which covers the year 1940–41, includes a brief review of the history of the Institute since its formation in 1938. The original research programme of the Institute, which was largely planned upon the basis of a two-year period, was prepared by special committees of the Institute constituted for the following subjects: (1) statistical studies of the national income and changes in its magnitude and distribution; (2) location of industry and the distribution of the industrial population; (3) British commercial policy and the administration of overseas trade; (4) the organization of the credit and capital markets; (5) short-period economic change; (6) economic and administrative problems of unemployment.

The work of 1940 fell into two sections; first, the continuation or completion of pre-war studies, and secondly, the war-time research programme adopted by the Council in December 1939.

In the first section (the national income) inquiry was continued throughout the year under the direction of Prof. A. L. Bowley, and a paper incorporating part of the work has been published in the *Journal of the Royal Statistical Society*. Studies of the location of industry have continued and a study of the social and economic conditions in the Highlands has been completed but not yet published.

A report on some of the results obtained on the location and concentration of industry has already been published, and although the industrial survey of Bristol was suspended in 1940, the results are to be published shortly. A report on part of the results obtained in the fertility studies in Bristol has also been published in the *Journal of the Royal Statistical Society*.

The first and descriptive part of the study of trade regulations and commercial policy in Great Britain has been completed, and work on the remaining part has been suspended. The manuscript is now in the press. A study of the organization of credit and money markets in London has been completed by Dr. Thomas Balogh and awaits publication.

The development of the war-time research programme in 1940 was hindered by the insufficient supply of research workers. Under this programme, grants have been made for studies of the effect of the War on the credit policy and credit mechanism of the City of London; the effect of war on municipal finance, Coventry; economic adjustment to the War in Birmingham; taxation of war wealth; burden of taxation inquiry; studies in Russian economic problems; inquiry into savings and spending and on the social consequences of evacuation in south-west Scotland as well as of juvenile employment in Manchester and in Glasgow, and a study of National Health Insurance by Prof. H. Levy. The programme also includes studies in exchange control by Dr. Thomas Balogh, and a grant has been made for a study of war-time changes in Bristol purchasing power, an investigation substituted for the continuation of work on the industrial survey which was suspended.

Since the heavy air raids on Great Britain in the autumn of 1940, damage to the Institute's premises necessitated alternative temporary accommodation, and hospitality was offered by the Royal Institute of International Affairs. During 1941, the research staff of the Institute was increased and the scope of its work expanded. The initiation of its series of publications was undertaken and arrangements were made with the Cambridge University Press to publish the Institute's researches. The report also refers to the work of the National Service Committee for Social, Economic and Statistical Research and of the Consultative Conference for the Co-ordination of Research in the Economic and Social Sciences in War-time.

In 1941, the greater number of applications were received from individual research workers and fewer from universities and university colleges. A list of studies in 1941 and of publications in 1940–41 is also included.

WHISTLING METEORS

IN an article on "Whistling Meteors" appearing in the November issue of *Electrotechnics*, Chamanlal and K. Venkataraman, of the research department of All-India Radio, discuss the Doppler effect produced by meteors entering the ionosphere.

During observations carried out on short-wave transmitters near the Delhi centre of All-India Radio, it was observed that in certain circumstances when a receiver was tuned to the carrier wave, weak heterodyne whistles of an unusual type were audible. The whistles appear as a high-pitched note which rapidly descends in pitch down to zero frequency where they apparently disappear, or alternatively fade away before reaching zero frequency. The whistles vary in duration from approximately a fifth of a second to several seconds and occur at random time intervals. They are most frequent in the early hours of the morning and are infrequently heard during the day-time, the early morning whistle sometimes occurring very frequently.

A heterodyne whistle which first appears with an initial beat frequency of, say, 3 kc./sec. and, after rapidly descending in pitch, disappears without reappearing on the other side of the fixed carrier wave can only be explained by the Doppler effect due to interference between the weak carrier wave reaching the receiving centre as a ground wave and a wave returned from a rapidly moving reflecting surface the latter suffering an apparent change in frequency Assuming a beat frequency of 3 kc./sec. and that the observation is made on a carrier frequency o 7 mc./sec., the velocity of the moving reflecting surface is found to be about 64 km./sec. The descending pitch of the heterodyne beat note is the result o the moving reflecting surface being rapidly retarde in velocity, and the beat note will reduce to zer frequency if the velocity of the reflecting surfac becomes zero. If the beat note disappears befor reaching zero, it may be assumed that reflectio from the surface has ceased before it has necessaril reached zero velocity.

A consideration of this particular manifestatio of the Doppler effect shows that if the reflecting surface is moving towards the point of observation th Doppler effect will appear as a heterodyne whistl on the higher frequency side of the ground-wav from the transmitter. This was confirmed on detuning the receiver slightly from the carrier frequency position. The Doppler effect from a recedin reflecting surface produces a heterodyne whistle on the lower frequency side of the carrier wave.

The only known phenomenon with which sufficiently high velocities are associated and which could cause a Doppler effect of this nature is a meteor entering the earth's upper atmosphere, and confirmation of this was obtained by observations in the early morning hours when the appearance of meteors in the sky coincided with the heterodyne whistle produced in a receiver. The article discusses briefly the number, size, height, and velocity of meteors, the mode of dissipation of meteor energy, and meteor ionization, remarking that the summary provided of some of the known properties of meteors gives ample confirmation of the experimental evidence and deduction that the weak heterodyne whistles observed are due to the Doppler effect caused by the rapidly moving ionized area produced by a meteor. It is evident that, (a) the ionization produced by meteors can be sufficient to reflect waves of the frequencies concerned, (b) the number of whistles observed is at a maximum in the early morning when the number and velocity of meteors entering the earth's atmosphere is greatest, and (c) the velocity of meteors, determined by visual means, is of the same order as that calculated from the Doppler effect observed.

The article concludes with descriptions of the experimental procedure adopted and the results obtained.

NEW DESCRIPTIONS OF SOME INDIAN PLANTS

SOME interesting botanical notes have recently been given by Dr. N. L. Bor, forest botanist, Forest Research Institute, Dehra Dun (*Indian For. Rec.*, Botany, 2, Nos. 2, 3 and 4; Govt. of India Press, Delhi, 1941).

In No. 2 the bamboo *Thyrsostachys Oliveri* Gamble s dealt with. This species, the author writes, owered in the Katha district, Upper Burma, in 1891. pecimens were sent by J. W. Oliver, conservator of forests, to the late Mr. Gamble, who pubshed a description under the above name in the *nnals of the Royal Botanic Garden*, Calcutta, in 1896. eeds of the species were also sent and these were lanted at Dehra Dun in several places, and also in ne Royal Botanic Garden, Calcutta. All those who ave known Dehra Dun during the last forty years ill remember the magnificent clumps of this bamboo. ll the Dehra clumps commenced to flower towards e end of November 1938, the first indication being e fading of the leaves, which soon began to fall off. n the first week of December the flowering shoots, ale purple in colour, were quite evident, and by ecember 12 the lower sheaths of the flowering oots were beginning to show the tip of an emerging ikelet. By December 23 two spikelets had cometely emerged from each sheath, and the six amens, pendulous at the ends of long filaments, ere visible from each of the three florets of the ikelets. Seed was ripe by January 31, 1939. Dr. or says that with fresh material to work upon and limited quantities of it, it became evident that the scription given by Gamble, prepared from dried aterial, required modification in several respects.

A lapse of twenty-four hours is quite sufficient for e features of the structure of the delicate palea to be lost, and no amount of boiling will restore them. This fresh material enabled a revised description to be drawn up which corrects some minor inaccuracies in Gamble's description. Two plates portray the details of the inflorescence and spikelets. This reads like a botanical romance, and foresters in Burma and botanists are likely to be equally interested.

For No. 3, Dr. Bor redescribes Dunn's *Vatica Shingkeng*, placing it in the genus Hopea. The original description was based on incomplete material, especially the flowers. I. H. Burkill, who accompanied the expedition into the Arbor Hills of Assam in 1911, discovered the species. He notes: "no general flowering took place during the expedition, and it was with great difficulty that one flowering tree was found". This flowering specimen was not, however, sent to Dunn, who notes in his description "*flores ignoti*".

In No. 4, Dr. Bor describes three flowering plants new to science: *Gleditsia assamica* Bor, *Garnotia puchiparensis* Bor and *Strobilanthes andamensis* Bor. Illustrations are given of each species. Dr. Bor had collected the Gleditsia in the Aga and Naga Hills and Sadiya in Assam without flowers or fruit. He received these collected in Sadiya in March 1938. It is a small deciduous tree about 10 metres in height.

The Garnotia is a grass and was found growing thickly in the clefts of a large rock just west of the Puchipara rest house, Silent Valley, Madras (alt. 3,000 ft.).

The Strobilanthes is a wiry shrub up to 60 cm. tall, gregarious in habit. The species was collected in flower by the sylviculturist of the Dehra Institute during a visit to the Andamans. It was noted that "the species was abundant in regeneration areas on limestone rocks, growing in crowded bushes 1′–2′ high".

DRUG CONTROL IN INDIA

THE problem of drug standardization and drug control in a country of the size and population of India is a vast one. In Great Britain, the United States and other progressive countries a general consciousness of the evils of food and drug adulteration on community health and national well-being was aroused nearly fifty years ago, and the authorities took up the responsibility of safeguarding public health and money by instituting adequate control of the spurious drug trade. In India, on the other hand, although the possible injurious effects of the adulteration of foods were recognized early enough, the seriousness of the situation arising out of the indiscriminate adulteration of drugs and chemicals for the treatment of diseases received comparatively little attention, and India came to be considered the dumping ground of all kinds of substandard, misbranded and poor-quality drugs and pharmaceuticals.

Realizing the need for both legislative and executive action the Drugs Enquiry Committee 1930–31, appointed by the Government of India, recommended that All-India legislation should be passed for the control of the importation, manufacture, sale and distribution of adulterated and under-strength drugs, and that machinery should be established for the regular collection and testing of drugs to ensure conformity to proper standards of purity and strength. It was suggested that for the standardization of drugs a well-equipped central laboratory should be set up with a competent staff of experts in various branches and that this should be supplemented with provincial laboratories working under the guidance of, and in close liaison with, the central laboratory.

In January 1937 the nucleus of a central laboratory (Biochemical Standardization Laboratory) was established, under the direction of Sir R. N. Chopra, in Calcutta, at the All-India Institute of Hygiene and Public Health. The Laboratory has now made satisfactory progress in the limited number of studies undertaken and has trained adequate personnel and laid sure foundations for future work in this field as evidenced in the triennial report (Report of the Biochemical Standardization Laboratory 1937–40. Government of India Press, Calcutta, pp. 92). During the three years preceding the introduction of the Drugs Bill in February 1940 it was thought that the best course for the Laboratory was to undertake a general survey of the quality of medical drugs in the Indian market and an examination of the specimens of drugs both imported and manufactured in India which were suspected to be of inferior quality.

Many drug manufacturing firms in India do not maintain properly equipped pharmacological laboratories with trained personnel capable of undertaking the standardization of chemotherapeutic preparations, and it was natural that ethical manufacturing concerns interested in the quality of their products should approach the only Government organization available with requests to have their products standardized.

In the initial stages the Laboratory had necessarily to restrict itself to certain definite drugs of comparatively greater importance to the pharmaceutical and medical professions. Routine analytical work was therefore largely concentrated on surveying the quality of tinctures of digitalis, strophanthus and squills, extract of posterior pituitary gland and adrenaline hydrochloride solution. In addition to the routine activities a good deal of interest in research problems on subjects which have a direct or indirect bearing on drug work was consistently maintained. For example, one of the first group of drugs which the laboratory investigated was the cardiac drugs of the digitalis series. Liquid preparations of these drugs deteriorate at a fairly rapid rate when stored under the climatic conditions existing in India, and factors leading to this deterioration and loss of potency have been the subject of investigation. Again, the estimation of the antidiuretic potency of pituitary extract in rats was given an extensive trial and found to be quite reliable and to compare favourably with the results obtained by the oxytocic method. In addition, the Laboratory has the responsibility of acting as the national centre for the maintenance and distribution of certain international biological standards.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Monday, April 13

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Discussion opened by Colonel Sir Charles Arden-Close, F.R.S.: "The Map of the Pacific".

Society of Chemical Industry (Joint Meeting of the Yorkshire Section and the Food Group) (at the Hotel Metropole, Leeds). Subject: "Colours in Foods". 3 p.m.—Mr. D. J. T. Bagnall: "Comments on Coloured Foods". 3.45 p.m.—Prof. J. W. Cook, F.R.S.: "Physiological Aspects". 5.15 p.m.—Dr. D. A. Harper and Mr. N. Strafford: "The Rapid Spectrographic Determination of Minute Amounts of Arsenic, Lead, Copper, and other Heavy Metals in Food-Stuffs Colours and Medicinals".

Tuesday, April 14

Chadwick Public Lecture (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. D. C. Graham: "Dangers from Rainfall in Urban Areas; Prevention of Flooding of Buildings and of its Insanitary Consequences" (Bossom Gift Lecture).*

Society of Chemical Industry (Chemical Engineering Group) (Joint Meeting with the Institution of Chemical Engineers) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "The Development of New Chemical Processes" to be opened by Mr. H. W. Cremer.

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 5 p.m.—Mr. J. N. Aldington: "Fluorescent Light Sources and their Applications".

Wednesday, April 15

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. C. Dawes: "Making Use of Waste Products".

Society of Glass Technology (at Elmfield, Northumberland Road, Sheffield 10), at 2 p.m.—Annual General Meeting.

Institute of Chemistry (London and South Eastern Counties Section) (at 30 Russell Square, London, W.C.1), at 6 p.m.—Dr. Hugh Nicol: "What the Plant does with its Materials".

Thursday, April 16

Town and Country Planning Association (in the Dome Lounge Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—"Planning for the Family".

Chemical Society (at the Royal Institution, Albemarle Street London, W.1), at 4.30 p.m.—The Rt. Hon. Lord Rayleigh, F.R.S. Sir Joseph J. Thomson Memorial Lecture.

Friday, April 17

Association of Applied Biologists (at the London School o Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), a 11 a.m.—Symposium on the Pathology of the Hop (Speakers: D W. Ware, Dr. W. G. Keyworth, Dr. A. M. Massee). 2 p.m.—Discussio on the Interpretation of Toxicity Data. (Speakers: Dr. H. Martir Mr. A. F. P. Parker Rhodes, Dr. C. Potter, Mr. D. J. Finney.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on c before the dates mentioned:

Lecturer in the Department of Mathematics—The Registra University College of Swansea, Singleton Park, Swansea (April 22

Head of the Engineering Department and Vice-Principal o the West Hartlepool Technical College—The Chief Educatic Officer, Education Offices, Park Road, West Hartlepool (endorse 'T.C.') (April 25).

Lecturer in Biochemistry in the Department of Physiolog —The Secretary, The University, Edmund Street, Birmingham (April 25).

Assistant Physicist in the Physics Department of the Radi therapeutic Research Unit of the Medical Research Council—Th Director, Radiotherapeutic Research Unit, Hammersmith Hospita London, W.12 (April 27).

Skilled Workshop Instructor familiar with modern machi tool practice, at the Medway Technical College, Senior Department Gillingham—The District Education Officer, Fort Pitt House, Ne Road, Rochester.

Female Assistant Physicists—The Ministry of Labour ar National Service, Appointments Department, Section B/E, Sardin Street, London, W.C.2 (quoting B673E).

Female Assistant Chemists—The Ministry of Labour and Nation Service, Appointments Department, Section B/E, Sardinia Stre London, W.C.2 (quoting B667E).

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

National Institute of Economic and Social Research. Report 1940–1941. Pp. 15. (London: National Institute of Economic a Social Research.) [1

Other Countries

Forest Research Institute, Dehra Dun. Forest Leaflet No. Synthetic Tall Oil. By T. P. Ghose and B. S. Verma. Pp. 4. (De Dun: Forest Research Institute.) 2 annas; 3*d*.

U.S. Department of Agriculture. Circular No. 606: Observati on the Biology and Control of the Treehopper *Heliria praealta* (Fow in Orchards of the Pacific Northwest. By M. A. Yothers and Paul Allen, Jr. Pp. 13. (Washington, D.C.: Government Printing Offi 10 cents.

Smithsonian Miscellaneous Collections. Vol. 101, No. 6: Bee of the Genus Hyperaspis inhabiting the United States. By Th. D zhansky. (Thomas Lincoln Casey Fund.) (Publication 3642.) ii+9+6 plates. (Washington, D.C.: Smithsonian Institution.)

NATURE

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University Physics Dept. Circular Calcu

RECONSTRUCTION AND THE BUILDING INDUSTRY

NOW that building for war has reached, if not passed, its peak, while the demand for man-power and woman-power is still increasing, it is imperative that an attempt should be made to face the post-war problems if physical reconstruction is to be possible on anything like an adequate scale when hostilities cease. The Central Council for Works and Buildings has already issued a valuable memorandum on "Training and Recruitment for the Building Industry", prepared by Mr. G. D. H. Cole for the Ministry on behalf of the Nuffield College Social Reconstruction Survey. Further, at a time when there is some public uneasiness at the delay in the Prime Minister's promised statement on reconstruction and over the supercession of Lord Reith and Mr. Greenwood, the Ministry of Works has issued a statement on the newly created Directorate of Post-war Building. The statement is reassuring evidence that, in one part of the field, preparation is being made to deal with problems which will become urgent immediately hostilities cease and which are indeed linked intimately with the question of demobilization.

The Directorate of Post-war Building consists of a small skeleton staff of fourteen people, but the statement indicates that it has fully grasped the significance of co-ordinating and unifying the many scattered activities of groups and committees in this field and giving them some coherence and direction, if at the appropriate time contraction is to be turned into rapid expansion and orderly and efficient advance. Its first task is that of collating existing information and co-ordinating all activities pursued elsewhere. Its field embraces the whole technical side of building and will include the planning and design of the many types of buildings; the latest practices in construction; the architectural use of materials (and particularly of the newer materials); the most efficient methods for heating, ventilating, lighting and sound-proofing a building, and generally giving it all the advantages that modern science and production technique have put within the reach of man.

The work will be done through groups or committees, most of which are actually or potentially in existence. Where necessary, new study committees may be created at the invitation of the Ministry, either by Government departments, professional organizations, research associations or other suitable organizations. Only in exceptionable circumstances will the Ministry itself convene a committee. Fifteen such study committees have now been discussed in detail or agreed; eleven have been or are being formed and several are at work. The Minister has already provided for co-ordination and policy through a main co-ordinating and three policy committees. All the major interests affected are represented on the main co-ordinating committee, including the Ministry of Health, the Royal Institute of British Architects, the Institution of Civil Engineers, the Department of Scientific and Industrial Research, and the British Standards Institution.

The three policy committees between them cover all subjects for which study committees have been appointed, and consist mainly of the chairmen of the relevant study committees. One of these policy committees, of which Sir Giles Scott is chairman, covers design; a second, with Mr. Ralph Freeman as chairman, deals with structure; and a third, under Mr. G. Grey Wornum, with installations or services. Of the six study committees in this group, two are convened by the Building Research Station, one by the Institution of Electrical Engineers, one, on illumination, by the Department of Scientific and Industrial Research; one by the Paint Research Association and one by the Plastics Federation.

It is clear therefore that in this attempt to seize the opportunity of a general overhaul which the almost complete stoppage of the mechanism of civil building affords, the Ministry of Works and Buildings is making full use of scientific research and technical experience. Past experience is being reviewed and new ideas examined and tried out. If all engaged in the industry respond to this call to pool their knowledge now, regardless of narrow individual interests, there should be an immense improvement in the value of buildings in Great Britain after the War, and the Director of Post-war Building, Sir James West, and his three assistant directors, have every right to count on the full support of scientific workers in their important task.

The statement of the Ministry goes far to meet some of the criticisms of the Association of Architects, Surveyors and Technical Assistants in a recent memorandum entitled "War-time Building". The programme already contemplated should at least remedy the inadequate exchange of technical information, as well as the lack of unified control of building work and of contact between office and site, and design and user, to which "War-time Building" points as among the factors leading to delay in building, inefficiency and the hold up in arms production. It should promote the provision of the unified control of the building programme and co-ordination of planning requirements and structural research which are among the main proposals of that report. Further, it should facilitate co-operation between technicians, which is one of the immediate steps proposed for professional action.

The great problem of the expansion or adaptation of the building industry is, however, the labour question. This may be described as both qualitative and quantitative. The first aspect involves the proper utilization of the technical or scientific worker, upon which the Association of Architects, Surveyors and Technical Assistants lays particular stress. The second is the main theme of Mr. Cole's memorandum, and both are discussed in a recent P E P broadsheet "Building for the Nation".

The Association of Architects, Surveyors and Technical Assistants maintains that insufficient responsibility is delegated to the technical worker, that initiative is discouraged, supervision inadequate and that the organization of technical workers is defective. Together with the lack of unified control of building work, the inequitable allocation of staff, mistakes in placing technical workers and the placing of unqualified persons in responsible posts, as well as the factors already mentioned, it is urged that these defects in organization are leading to considerable waste and inefficiency in war-time. The proposal for full recognition of the status of the technical worker is substantiated by the P E P broadsheet, and also by reports of the Select Committee on National Expenditure.

There is indeed little reason to doubt that the weaknesses which are at the root of the building industry's troubles to-day are due to failure to define responsibilities, to prevent overlapping of functions and to co-ordinate specialized activities. *Planning* lays down the basic principle that the responsibility for design and for co-ordination of services involved in the preparation of plans and other documents for subsequent general supervision should rest upon the architect or engineer. Responsibility for measurement services—quantities and costs—on the basis of the particulars provided, should, in accordance with the proposals of the Association of Architects, Surveyors and Technical Assistants, be placed entirely on the quantity surveyor. Responsibility for co-ordinating work in progress should be clearly defined, and if it remains a responsibility of the architect, co-ordination must be provided much more efficiently than is possible at the clerk of work's or general foreman's level. *Planning* visualizes three ways of providing the threefold service of co-ordination, design and measurement: by the architect and individual specialists; by groups of architects; and by an inter-professional group. The suitability of these types of professional organization will depend upon the scale and complexity of the work in hand. Responsibility and payment for design, measurement and professional co-ordination services should be kept completely distinct from the provision of building materials and from contracting and sub-contracting work. Further, salaries offered to technicians in public services should compare favourably with those offered for similar work in private employment in order to make it possible to enlist the best brains available. Further scope should be provided for the recruitment of a proportion of senior officials at a more mature age after varied experience of normal private, industrial and professional conditions.

The co-ordination achieved through this reorganization of design and measurement services should be directed to ensure proper particulars as the basis of building policy and of national standards of cost control. The organization of the services of contractors calls for a similar critical analysis, and it is highly desirable that the services of the building contractor should be governed by professional standards comparable with those of the architect, the surveyor and the engineer. The absence of any definite pattern of professional relationship throughout the building industry and the dearth of technical administrators from which building organization is suffering, particularly in the Government service, find pointed comment in the P E P broadsheet, which also emphasizes the vital necessity of greatly extending the existing Government research stations both in scope and in size to meet the demands likely to arise after the War. Scientific research, statistical investigation and information services should be vigorously developed to bridge the gap between building research and practice, to stimulate attitudes of self-criticism and to accelerate the adoption of up-to-date methods.

The broadsheet lays particular stress upon the great responsibility of the recently created National Council of Building, although it concentrates its attention on a few of the vitally important aspects of the industry, particularly the long-term policies, including education both at the professional and the operative level. The importance of protecting the consumer, particularly by means of scientific research, and the desirability of exorcising haste from building policy, thereby ensuring speed, and the opportunity which the Government now has as the sole building owner in war-time of improving the efficiency of the industry, are other points stressed in this admirable survey.

The quantitative aspects of the labour problem are also visualized. The new forms of organization to be developed are one means of achieving the best output with the minimum of man-power, and the new status for contractors and the improvement of professional standards generally should have as counterpart a new status for labour. This implies the development of trade unions themselves more on the lines of professional bodies, concerning themselves more with education and the ability of their entrants, and with their opportunities for gaining wider qualifications—for example, by training schemes and a more constructive approach to apprenticeship.

Real developments in this field depend upon effective permanent measures to abolish under-employment and to secure to the workers the sure prospect of a steady load on the industry through large-scale planning. It is to this aspect that Mr. G. D. H. Cole's "Memorandum on Training and Recruitment for the Building Industry" directs special attention. The possibility of bringing about without friction an expansion of the labour force of the building industry on the scale required for post-war reconstruction depends, Mr. Cole concludes, on the giving of adequate assurances that building activity will be maintained at a high level over a considerable period of years. The prolonged depression in the industry before 1914 had disastrous consequences both in checking the flow of apprentices into the building crafts and in causing, in the period after 1918, a deep-seated fear that the acceptance of any schemes for dilution or the recruitment of additional workers would only mean heavy unemployment in the years to come. The building workers were not induced to co-operate readily in schemes of expansion until in 1924 Mr. Wheatley gave guarantees of a continuous programme of building at a high level, and thereafter the great trade depression of 1931 dealt a fresh blow to confidence.

Mr. Cole points out that the building worker needs to be satisfied on two points. He wants an assurance that any building policy requiring an influx of additional labour will be maintained for a substantial period; and he wants also, particularly if he belongs to one of the outdoor trades, a guarantee that his earnings will not be seriously affected by loss of time owing to bad weather conditions. These two requirements are not unreasonable. They are in keeping with the four freedoms of President Roosevelt and with the terms of the Atlantic Charter, and should be met as a preliminary to the introduction of ambitious programmes for the expansion of the supply of building labour.

While, as Mr. Cole's inquiry shows, it is quite impossible, apart from considerations of policy, to make any prediction about the total demand for building labour after the War, that very dependence upon policy, both in relation to housing and in relation to industrial and other non-residential building, should facilitate rather than hinder the giving to the industry of a guarantee of employment at a high level for a period of at least ten years. Obviously it is desirable to plan for the physical reconstruction of Great Britain over a considerable number of years, beginning mainly with the repair of damage by bombs and the arrears of repairs and maintenance, and thereafter proceeding to large schemes of urban re-planning and rural development which will involve the complete rebuilding of many congested areas, as well as substantial changes in the location of industry and population. Here Sir John Orr's plan for a 'temporary' housing scheme might be considered. Mr. Cole enumerates fourteen major points of policy requiring decision before any prediction can be made as to the size to which the building industry must be expanded after the War, but he assumes that the basic problem will be that of getting into the industry as many skilled, or fairly skilled, workers as can be made available by extensive measures of training, and that the actual volume of post-war building activity will depend at least as much on the success achieved in expanding the skilled labour force as on any other factor.

The 'wet time' problem should be solved by means of a guaranteed week, financed at least in part by some sort of pool to spread the cost over industry as a whole. Reassurance on these two points, Mr. Cole considers, would ensure trade union co-operation in bringing about the expansion of the industry on the required scale. Any public formulation of post-war policy for the expansion of labour supply should begin with plain declarations on these two questions. The rebuilding of Great Britain should be planned in advance as a process to be spread over a period of years, divided into successive stages; and the 'wet time' question should be tackled simultaneously by the grant in some form of the guaranteed week.

If this be done, the trade unions of the building industry can be safely asked to waive, for the time being, any regulations which seriously restrict the number of apprentices, either for a particular firm or for a whole district, and also to co-operate closely in bringing into the industry an additional supply of skilled labour. Mr. Cole's proposals include working out in advance a scheme for the completion of interrupted apprenticeships, as well as of a national apprenticeship scheme for the various building crafts.

Mr. Cole recognizes the importance of making the fullest possible use of the available technical colleges and other technical institutions, of expanding the facilities for institutional training in the building crafts and professions, and of providing for vocational specialization in building and kindred techniques in both secondary and part-time continuation schools. The possibilities of the junior technical schools, which offer boys of thirteen a three-year course of secondary education with a strong vocational background, have already been emphasized in a preliminary report by the Education Committee of the Central Council for Works and Buildings. The fresh outlook which Mr. Cole brings to the problem in his comprehensive analysis is, however, particularly well illustrated in his proposal that the training of 'handymen' working for small repairing and decorating firms should be recognized by the industry as a problem requiring special action. Such recognition would in effect mean recognizing a new craft, but Mr. Cole urges that definite provision should be made for training workers of this type.

Here as elsewhere, the post-war policy of expansion may involve considerable modifications of the existing rules of demarcation between crafts. The use of the new materials means training in new crafts and processes, and a new and wider outlook on the part of the trade unions as well as of management and professional men. We cannot expect that outlook and the full co-operation essential to success unless, as Mr. Cole insists, we tackle first the problem of social security and, by eliminating the fear of unemployment, bring a new spirit into the industry. This point was stressed by Lord Portal, the new Minister of Works and Buildings, in an address on April 8 to the National Federation of Building Trades Employers, discussing the importance of organization for immediate activity on the close of hostilities, when he stressed the need for ensuring continuous work for the operatives of the industry.

The dominant note of these surveys is one of opportunity. There are many problems of organization to be solved, questions of professional training, of education and research, if we are to realize the possibilities which the new materials have put into our hands, as the Director of the Building Centre, Mr. F. R. Yerbury, showed in a recent paper before the Royal Society of Arts, on the adaptation of design to standardization and mass production. The statement of the Ministry of Works and Buildings shows that the Ministry is fully alive to the opportunities which lie before it. The most important step, however, remains that of creating the right outlook and inspiring the right spirit from top to bottom of the industry. For this reason the Ministry could give no firmer assurance of its determination to discharge its responsibilities than by dealing with this question of social security. Action in that respect now would fortify and intensify the whole national purpose and effort by giving an earnest of the Government's determination to see that the new order to be established after the War will be worthy of the sacrifices now demanded of every man and woman.

PHILOSOPHY AND THE SCIENCES

Hippocratic Medicine: its Spirit and Method

By William Arthur Heidel. Pp. xvii+149. (New York: Columbia University Press; London: Oxford University Press, 1941.) 13*s*. 6*d*. net.

THE exact relationship of philosophy to the sciences has long been a much-debated subject, although there is to-day general agreement among the writers on ancient thought. The older generations of historians tended to regard the earliest philosophy as similar to modern science in object and method, although they admitted, or rather assumed, its strongly metaphysical character. Recently, however, efforts have been made to prove that Greek philosophy was entirely different from modern science. It did not aim, it is contended, at increasing man's control of Nature, but at satisfying his religious instinct; the method adopted was not induction, with observation, experiment and verification, but dogmatic assertion of rational but unverified—sometimes unverifiable—hypotheses. In other words, it was a theology based on faith. This was 'philosophy' in its narrow sense. There was a wider, vaguer meaning, according to which it embraced logic, ethics; education and so on, if studied in a serious and systematic way, but it bore no resemblance to the physics and chemistry of modern times.

In his book on Hippocratic medicine the late Prof Heidel put forward the theory that, besides being philosophers, early Greek thinkers were also scientists who tried to classify and explain phenomena and sense-perceptions. His evidence is practically limited to the sphere of medicine, but the seventy works of the Hippocratic "Corpus", written between 450 and 350 B.C., afford plenty of material. While fully realizing their faults, Heidel believes that the writers of these works were scientific (in the modern sense in (1) their general conceptions, for example, that the nature of man cannot be understood apart from universal Nature of which man is a part; and in (2) their practice of using scientifically the few means and instruments available in their day. In other words they had the scientific attitude of mind. Their chief faults were that they were dogmatic and speculative regarding as simple what was really complex.

Without these medical works, says Heidel (p. 18) the fragments of the philosophers are scarcely intel gible. For the influence of Plato and Aristotle—particularly of Plato—was so great that the stress they laid upon a narrow metaphysic has obscured th whole history of thought, casting into oblivion nearly all the evidence for the development of Greek science The medical treatises alone have survived, havin been saved by their practical utility.

Such is the theme of Heidel's book. It has it faults; the author, for example, failed to appreciat the unique character of Greek metaphysics, makin rather strange statements about the early philosophers. Nevertheless, if the main contention be correct, much of the history of philosophy must b re-written, and our conception of Greek though freed from the metaphysical bias due to the outstanding genius of Plato. Heidel knew the Hippocratic treatises through and through, expounding the views and explaining their attitude with accurac and thoroughness. All future historians of Greek thought must regard these medical works as primar authorities, instead of using fragments of them as is the modern practice, as secondary authorities to reinforce conclusions based on very different material. As evidence for the development of thought they are as valuable, or almost as valuable, as Plato and Aristotle. W. H. S. JONES.

AN INTRODUCTION TO METEOROLOGY

Introduction to Meteorology

By Prof. Sverre Petterssen. Pp. ix+236. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 17*s.* 6*d.*

THE author of this book is immediately faced by the problem of deciding how much knowledge of mathematics and physics he can assume his reader to possess, since meteorology is concerned with the physics and dynamics of the atmosphere. Dr. Petterssen has assumed that his reader has a knowledge of the elements of the differential calculus, and of rather more than the rudiments of the theory of heat. On this basis he has written a book which can certainly be added to the relatively short list of good books on the subject of meteorology. The general bias of the book is implicitly in the direction of applications to aviation.

Of the fifteen chapters into which the book is divided, Chapters 8–13 are directly concerned with the synoptic chart and its use, and the first seven chapters have been written with the aim of supplying the theoretical ideas underlying the use of synoptic charts for weather forecasting. The earlier chapters cover the consideration of evaporation and condensation, adiabatic changes, stability and instability, temperature changes and their relation to weather phenomena, and wind systems. These are all discussed rather briefly, but on the whole very clearly. The present reviewer was particularly impressed by those portions of the book which are devoted to types of precipitation, types and modes of formation of fog, the genesis of air masses, weather analysis and the steps in forecasting procedure, and the detailed discussion of examples of charts for western Europe and the eastern Atlantic. The parts of the book which deal with synoptic charts are, as might be expected from one who has taken an active part in the development of the Norwegian methods of forecasting, clear and full of matter of great interest to the student of weather forecasting.

The author's view of what constitutes an elementary treatment of meteorology does not accord with the popular view. His book will demand close attention on the part of the reader, as it is very much concentrated. It would probably have been beneficial, from the reader's point of view, to have amplified portions of the earlier chapters. For example, where the formula for the dry adiabatic lapse-rate is expressed as g/c_p, on p. 52, it is not explained that the specific heat at constant pressure is to be expressed in dynamical units, though the elementary reader would probably think of this quantity as expressed in heat units. The actual values of the constants used in the formulæ are not given, and it would be helpful to the reader to have these constants collected into a table, so that if required their values could be readily ascertained. The numerical value of the dry adiabatic lapse-rate is given, on p. 53, as 5·6° F. per 1,000 ft., instead of 5·4° F. per 1,000 ft., the value which the formula yields.

The last two chapters give Köppen's classification of the climates of the world, and a brief historical review of the development of meteorology as a science. Dr. Petterssen concludes his book with an optimistic view of the future of weather forecasting, but whether that view will be justified or not, it is safe to forecast that the book under review will have its part in the spread of knowledge of modern meteorological methods. D. BRUNT.

ENGINEERING DATA

The Engineer's Year-Book of Formulæ, etc.

Originally compiled by H. R. Kempe and W. Hanneford-Smith. 48th annual issue, revised under the direction of L. St. L. Pendred. Pp. xii+2852. (London: Morgan Brothers (Publishers), Ltd., 1942.) 35*s.* net.

SHOULD some future historian wish to write of engineering in 1942, he will find most, if not all, of the important facts in "Kempe". Practically every branch of engineering is represented, as the full title shows, the only notable absentee from the list being chemical engineering which, on the purely engineering side, may be said to derive from certain aspects of other sections—civil, mechanical, electrical and metallurgical—while on the chemical side it belongs to another branch of technology.

The present edition marks the occasion of the quinquennial revision, which is made the opportunity for a thorough overhaul of each of the forty-seven sections in which the information is presented. Obviously, of course, the great bulk of the book remains very largely as before, for much of it is fundamental and almost permanent, and the rest has been carefully selected and tested in previous years. The mining section is one of those that have undergone major treatment and the work of the late Dr. Henry Louis has been revised, considerably extended and brought up to date by Sir Richard Redmayne, whose authority in the world of mining gives assurance that this section is now fully in line with the most recent knowledge and standards.

Other sections which have received similar treatment include those on steam, hydraulics and hydraulic transmission of power, marine oil engines and aero engines. As a result, "Kempe" is not only a larger volume but also has made a definite advance in conformity with the manifold activities of the great body of engineers.

Besides the practical information relating to these numerous aspects of engineering operations and design, the earlier sections are devoted to the more fundamental data which are in constant demand both by the student and by the practising engineer. These include units of measurement and equivalents, the principles of mechanics, measurement of power, heat, optics, acoustics, vibration, noise, the properties of engineering materials and metering and mechanical testing appliances. Then again, in the building section, there is given an abstract of the provisions of the London Building Act, which for some time to come will be the principal guide to conventional and approved practice. By its comprehensive inclusion of engineering information, "Kempe" is equal for purposes of reference to quite an extensive library, and the information is more accessible and more easily applied.

Physical Chemistry for Colleges

A Course of Instruction based upon the Fundamental Laws of Chemistry. By Prof. E. B. Millard. (International Chemical Series.) Fifth edition. Pp. ix+600. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 26*s*.

PROF. MILLARD'S book has now reached its fifth edition. Like many American text-books of science it is excellently printed and bound, but its price is notably greater than that of British books which are of a similar scope.

The treatment follows the usual lines so far as the older 'classical' physical chemistry is concerned, but is noteworthy for the care which has been taken to provide many tables of experimental data and accurate modern values of experimentally determined constants. These are used as the basis for an unusually large number of numerical exercises which are appended to each chapter. Discussions of the states of matter, of the properties of solutions and of thermochemistry and thermodynamics are clearly written and copiously illustrated. The discussion of kinetics is confined to the treatment of homogeneous reactions.

The least satisfactory chapters deal with more modern work, and the discussion of atomic structure does not seem to have been rewritten since the book was first published in 1921. It gives a brief account of the Lewis cubical atom and of the Bohr theory of the hydrogen atom, but does not include even a description of the general Bohr theory of extranuclear structure and the periodic law which is now so fundamental for chemistry. This omission should be rectified in any future editions. S. S.

Practical Physics

By the Physics Supervisory Staff, Engineering Science and Management Defense Training, under the direction of the Division of Arts and Science Extension, the Pennsylvania State College. (Foundations of Engineering.) Pp. viii+165. (State College, Pa.: Pennsylvania State College, 1941.) n.p.

THIS course is designed for a very specific purpose, namely, to furnish training in the fundamentals of physics for workers in the defence industries of the United States. The scope of the work includes the usual subjects, with the exception of sound and light, of a standard roughly equivalent to the School Certificate in England and Wales; in some cases the standard is slightly higher.

The first chapter deals quite adequately with fundamental units and their measurements, and this chapter is typical of the thorough manner in which the work of the whole book has been done; each chapter is practically a self-contained unit. The general plan throughout the book seems to be to deal with the theory first, follow this up with a useful summary and a comprehensive set of questions, and then deal with the experimental work. In the examples, emphasis is placed on the practical and industrial applications of the principles studied. Many diagrams are given, but several of these are in lighter vein and could easily be omitted.

Much has been attempted in the book, and much accomplished, and one feels that the students for whom the book is intended should derive great benefit from its use. The authors are to be congratulated on their enterprising and sound piece of work.

Elementary General Science

Edited by J. M. Harrison. Book 3. Pp. vii+247. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 5*s*.

THIS rather high-priced book completes a course in elementary science from which it is suggested that schools select subject-matter to suit their own particular needs. The earlier chapters are arranged so as to interlink the various sciences so far as possible, while the remaining chapters deal with work necessary to meet the requirements of students taking the general science paper in the School Certificate Examination. One distinct asset of the book is the good sectional diagrams which are made as simple as possible so that students can very easily follow them; the diagrams of microscopes and telescopes are particularly good. It must be distracting to students, however, not to find diagrams on the same page as the corresponding descriptive matter; examples of this occur on pages 167 and 169.

Certain omissions, which one feels ought to be remedied, are noticeable. For example, in dealing with the mechanical equivalent of heat, Joule's pioneer work is quite rightly stressed, but a more modern method of determining this important relationship would have been welcome. There is a good selection of questions at the end of the book, though no answers are given to the numerical problems.

Experimental Physical Chemistry

By Dr. W. G. Palmer. Pp. xii+322. (Cambridge: At the University Press, 1941.) 12*s*. 6*d*. net.

DR. PALMER'S new volume is noteworthy for the simplicity of the apparatus used to demonstrate fundamental laws and for the very detailed instructions which are given for carrying out the experiments. Each chapter is prefaced by a condensed account of the relevant theory; this is done so that (to quote from the preface) "the student can readily refer to principles while at work on a problem".

This is a very desirable aim but it is doubtful whether the highly compressed and sometimes inadequate notes on the theory will really help the more earnest student. Dr. Palmer's book will chiefly be valued for the many practical dodges which are described for the construction of home-made apparatus. S. S.

Practical Physical Chemistry

By Prof. Alexander Findlay. Seventh edition, revised and enlarged. Pp. x+335. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 12*s*. 6*d*. net.

PROF. FINDLAY'S book has now reached its seventh edition; it was first published in 1906 and the last impression of the sixth edition appeared in 1938. The new edition is enlarged by the inclusion of descriptions of modern equipment for thermostats and, *inter alia*, some additions to the sections on surface tension, electromotive force, and binary and ternary equilibria.

The author has wisely resisted the temptation to enlarge the book considerably by the inclusion of many new and specialized topics. After more than three decades of useful life it remains an excellent and inexpensive guide to practical work in physical chemistry. S. S.

A Review of Driers and Drying

By E. F. Bennett. Pp. 90. (London: *Paint Technology*, 1940.) 3*s*. 6*d*. net.

DESPITE the age-old use of linseed oil as a medium for protective and decorative finishes, it is only in comparatively recent times that a serious attempt has been made to study the fundamental aspects of the drying phenomenon. In this review on driers and drying the author has attempted to collect and collate the large volume of published work which by now has accumulated in scattered technical journals, and to present a concise and critical survey of the existing knowledge. The entire field bristles with intricacies. The drying oils themselves are complicated mixtures and the transition from the soluble liquid state to the final insoluble solid film is the result of the interplay of complex physical and chemical changes.

Though small in compass, the book is comprehensive in treatment. It covers the constitution of the various oil types, the general principles of the drying phenomenon, the respective roles of oxidation and polymerization in film formation, the influence of metallic driers, film structure, the constitution of varnishes and the influence of pigments. This admirable compilation of the information on drying oils and driers with its 106 references is interesting and valuable from the theoretical point of view and at the same time it offers much practical and useful information for the guidance of the paint technologist.

The book is highly recommended by two acknowledged authorities on the subject, Dr. J. S. Long and Dr. William Krumbhaar, who in extended forewords contribute lucid and suggestive analyses of the problems awaiting solution by research workers in this field.

The Twin Marchant Calculating Machine and its Application to Survey Problems

By Dr. L. J. Comrie. Pp. 40+3 plates. (London: Scientific Computing Service, Ltd., 1942.) 10*s*.

IT would be difficult to exaggerate the importance at the present time of easy and rapid methods of solving the day-to-day mathematical problems that arise in military survey work. A large number of such methods, many developed by Dr. Comrie himself, depended in the past on the use of the German Brunsviga Twin 13*z* calculating machine. The fact that this machine is now, naturally, unobtainable might well have seriously handicapped our fighting forces. It is therefore extremely gratifying to learn that a substitute has been provided by the device of building together in pairs the well-known American Marchant machines. As Dr. Comrie remarks, this improvisation does not produce the ideal twin machine, but at least it gives us a serviceable and urgently needed war weapon.

Dr. Comrie's booklet describes this Twin Marchant and deals in detail with its application to about a dozen of the fundamental problems of survey work. The methods, which make full use of the time- and labour-saving possibilities of the machine, are described clearly step by step. The book assumes no knowledge of calculating machines on the part of the reader, and so eleven of its large pages outline fully the use of the ordinary single-hand calculating machine and many of the tricks which experienced computers use to shorten their labours. These pages will be useful, not only to those who have to deal with survey problems, but also to a very much larger class of computers and particularly to beginners.

S. L.

Elementary Physics and Chemistry: for Students of Biology

By Dr. E. A. Woodall and E. C. Denne. Pp. 224. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1941.) 4*s*. 6*d*.

THIS volume is intended as a two-year course to cover the work necessary for students taking biology in the General Schools Examination, the work to be done in the two years preceding the examination year. The chemistry portion is relatively thin, for the authors point out that little subject-matter is required and much of this can be taught in its proper context in the biology course. In the physics portion, on p. 17, the student is told that inertia is a *property*; later he is told that mass is a *quantity* of matter; he will probably be a little fogged when, immediately after this, he reads that "mass and inertia are really the same thing", even though there is a qualifying note. Not everyone will agree that the section on light should start with the spectrum, to be followed by reflexion and refraction, and one wonders why the experimental methods illustrating laws and principles are placed all together towards the ends of the chapters instead of putting them in their proper place in the text.

The diagrams in the book are simple and well done (incidentally Fig. 116 is not quite up to date), and a very useful feature is the use in biology of the principles discussed.

The Story of Electromagnetism

By Sir William Bragg. Pp. 64. (London: G. Bell and Sons, Ltd., 1941.) 1*s*. 6*d*. net.

THIS booklet is a reproduction, with certain modifications, of a lecture given by the late Sir William Bragg to cadets of the A.T.C. in the London area. It must have been a 'red-letter' day in the lives of these youths to have had the privilege of listening to so eminent a personality and one so renowned in the field of science. The purpose of the lecture was to give a sketch of the gradual realization of the fundamental principles of electromagnetism, principles on which a great deal of the future work of the cadets is based. The treatment of these principles is rather unique, and could only have been done in this way by the expert, the master of his subject, as was Sir William Bragg.

In the first chapter the four fundamental principles of electromagnetism are set out, and in subsequent chapters the author follows the course of discovery, observing the events which led up to the recognition of each of the principles. The amount of ground covered in this small book is very extensive, and the book should be studied not only by A.T.C. cadets but also by those who train them and by all students of physics.

Sir William Bragg added here one more notable contribution to the many he rendered to the world of science, and it is characteristic of him that, in his last published book, small though it is, he should have returned to fundamentals, discussing them in his own inimical way chiefly for the enlightenment and stimulation of the younger generation.

RACE AND FASCISM

THE second of the two symposia recently arranged by the Faculty of Science of Marx House (Marx Memorial Library and Workers' School) was held at the London School of Hygiene and Tropical Medicine on Easter Monday, April 6. The session was concerned with "The Scientific Attitude to Fascism with particular reference to Racial Theories", and Dr. C. S. Gibson acted as chairman. Six papers were read. It was understood that the views expressed were not necessarily those of Marx House, and the speakers were united more by a common interest in refuting Fascist ideas than in supporting Marxism.

The three papers read during the morning meeting dealt chiefly with race considered as a biological concept. Prof. J. B. S. Haldane opened with a discussion of "Racial Theories and Biological Fact". His chief concern was in rebutting the Nazi racial theory. This was said to be based on three main propositions: (1) that racial differences are absolute and that they determine cultural differences; (2) that some races are superior to others; and (3) that racial crossing is harmful.

The assertions made under the first head, Prof. Haldane said, are "un-Darwinian and undialectical". Races are nothing fixed: they were formed and evolved through the interaction of isolation and mixture. It is probable that whites and Negroes arose by specialization from brown peoples, and in other instances the existence of populations of intermediate type can be attributed to crossing. That there is no essential correlation between race and culture is demonstrated by the fact that very different races have passed through very similar cultural stages.

In adaptation to climate one race may be supposed superior to another in a particular environment, but there is little evidence for superiority in innate aptitude for civilized life. Many observed differences can be attributed to tradition, diet and, above all, chronic disease. Alleged superiority might be due to higher average performance, or to the greater frequency of gifted individuals. It has not been demonstrated that any race surpasses another in either respect, but even if it had, the overlap found would be too great to justify discrimination against the inferior race. Adequate investigation of these matters would require comparison of large samples under conditions of equality in differing environments.

The third point, regarding the harmfulness of racial crossing, is not substantiated by any genetical evidence. On the contrary, hybrid vigour might be expected in the first generation, though no example of it can be given in man. The mixing of cultures may be as important as that of races, and a hybrid culture may be of great value to humanity.

In conclusion, Prof. Haldane stated that believers in racial superiority commonly believe also in the superiority of their own class within the race, and he stressed the scientific importance of studying the social origins of racial theories as well as the theories themselves.

Dr. G. M. Morant, who followed with a paper on "The Meaning of Race", pointed out first that scientific workers have hitherto failed to reach any general agreement regarding racial problems. They are the special concern of physical anthropologists, who agree to-day in supposing that race is a biological matter which must be judged from body characters and not from cultural evidence. The term is applied to sub-groups of the modern species of man which have to be distinguished in order to discover how the total group evolved. The aim is to construct a pedigree in which the units are populations and the ideal groups may be called races.

The most important conditions involved in defining and classifying races of mankind are: (1) the fact that characters show gradations in conformity with the geographical positions of the populations compared, and (2) the fact that different characters distinguish populations in different ways. It follows from (1) that races can only be defined in an arbitrary way, and there is no agreement yet regarding the conventions and nomenclature which can best be used. Analysis on statistical lines offers the best hope of leading to a satisfactory solution of the complex problem, and this need not conflict with any knowledge regarding heredity in man.

Finally, Dr. Morant pointed out that the biological conception is entirely antagonistic to the view, derived from cultural evidence and used for purposes of national propaganda, according to which races are populations which can be sharply divided from one another.

Dr. P. A. Gorer's contribution dealt with "Disease and Race". He discussed the facts that the incidence of certain diseases varies greatly in different areas and that such differences may exist between different ethnic groups inhabiting the same area. The problem is whether this diversity is genetical in origin or due to other causes.

The case of yellow fever was cited as an example of the difficulty of interpreting the evidence. The high resistance shown by West African Negroes might be attributed solely to genetical factors acquired through natural selection. It is doubtful whether this is entirely true, however, since the disease is much less severe in childhood, so that most of the adults will have been immunized as children. Population differences in the incidence of cancer may be due to environmental rather than genetical factors. Both kinds must be supposed involved in the case of infectious diseases. Knowledge of the etiology of mental differences is less developed, though it is in this field that the most dogmatic assertions regarding racial distinctions are made.

The moral drawn by Dr. Gorer is that appreciation of the difficulties to which he referred should act as a deterrent against hasty deduction from racial differences of other kinds.

Questions asked following these three papers related to 'identical twins', intelligence tests and cancer in Java, among other topics. One speaker raised a current political issue in asserting that an attempt was being made to disrupt India on racial grounds. As a result a resolution was passed unanimously during the afternoon to the effect that: "This meeting . . . deplores any attempt to base political boundaries on alleged racial differences, and in particular the suggestion that the peoples of India should be divided politically on racial grounds".

It cannot be said that the adoption of this motion was an example of the working of a democratic practice at its best. The matter was not discussed, and few people in the audience can have appreciated its implications. Has anyone suggested that India should be partitioned on the basis of race? As Prof. Haldane had pointed out earlier in the morning, it is commonly supposed that there are racial distinctions between castes of Hindus. He and the other speakers had emphasized the point that race is an ill-defined concept, from which it may be inferred that use of the term in concise statements of political significance should be avoided.

The afternoon meeting was opened by Mr. C. F. C. Hawkes, who spoke on "Prehistory and European Civilization". His theme was the group feeling of nationalism. This is always associated with some sort of belief in a distinctive group ancestry, but its main concern is belief in a distinctive cultural inheritance.

Racial theories used as national propaganda aim at intensifying both beliefs by disseminating dogmas regarding a nation's biological and cultural past conjoined. It is alleged that the doctrine is guaranteed by several branches of learning, of which prehistory is one. Racial nationalism declares that there were distinctive 'pure' races in prehistoric times, even if they cannot be found to-day. In fact what prehistory finds is culturally homogeneous groups. Cultural distinction must embody distinctive factors of habitat, economy and social structure, and it cannot be supposed that these are entirely without a biological counterpart. Nationalist race prehistory is not mere fiction but falsification of something real.

Mr. Hawkes then outlined the cultural development of the German region. In neolithic times it received elements of civilization indirectly from the Near East. A homogeneous Bronze Age culture resulted from the fusion of the neolithic people with invaders from the east who had retained the nomad tradition of the steppes. This encouraged the belief that the distinctive German culture was due to a distinctive group ancestry, although in fact the Bronze Age Germans largely migrated during the Iron Age. The tradition of German culture has always been associated with strong group feeling, and it has been peculiarly compact since prehistoric times. Belief in its distinction is deep-rooted, but it might be modified by re-education. Prehistory can play a part here by emphasizing the truth that progress has been conditioned not by racial exclusiveness but by the mingling and interaction of peoples and cultures.

From the questions which were asked regarding the archæology of Europe after Mr. Hawkes's paper, there had evidently been general appreciation of the importance of prehistory in refuting assumptions of the exclusiveness and superiority of Germanic culture. In that way, a study which may appear at first to have no practical applications must be taken into account in examining racial beliefs which are of great practical importance.

Prof. H. Levy dealt with anti-Semitism from the 'materialist' point of view, and he stressed the need for an objective treatment of the topic. Two questions examined were: (1) Why have the Jews survived? and (2) Why does anti-Semitism exist and reach climaxes at different times? Answers depending on the assumption that the Jews cannot be assimilated because they are of a distinctive type, or because they have a divine mission, can obviously be discarded. A proper appreciation of the situation can only be obtained from the history of the people. Their wide dispersion in Europe occurred at a time when the feudal system was in force, and they had no place in it. Consequently they remained without roots in any country. Being 'mobile', they were liable to be used by one party against another at any time of social crisis. The Jews were hence driven inwards and they persisted as a coherent group, clinging to its own traditions. Outbreaks of excessive anti-Semitism have always been associated with national revivals, and the correlation between the two can be traced from the Crusades to modern times. According to Marxist interpretation, a solution of the Jewish problem is essentially linked with a solution of the social problem. Prof. Levy's view is that both have been solved together in the U.S.S.R.

Miss Dona Torr discussed "Race, Nationality and Class" from a Marxist point of view. She was concerned with the political and social concept of race. An outline was given of the way in which historical materialism interprets such questions as the development of national unification and its relation to capitalism, class and international affairs in different historical phases. The social origin of certain racial theories of political significance and the Marxist view regarding the right to national independence were then discussed. In conclusion, she referred to the treatment of 'nationalities' in the U.S.S.R. It was stated that their territorial autonomy is recognized and that their languages and cultures are fostered.

The discussion following the last two papers was concerned with political rather than scientific topics. In winding up the proceedings, Prof. Haldane claimed that this was the first occasion on which any British organization had devoted a whole day to the examination of Nazi doctrines. He regretted the absence of an opposition, which was due to the fact that he had been unable to persuade anyone to speak in support of them.

One general impression gained by the spectator was that the question of race is a focal point where contact is made between specialists in many different branches of knowledge. Some, such as psychologists and demographers, were not represented in the symposium. It is clear that the definition of race and races is primarily the concern of biologists, and several branches of biology are involved. In a secondary way all humanistic sciences are concerned with racial differences, and it is not necessary to stress to-day the importance of the part that dogmas regarding them may play in social, political and international spheres. In order that science may refute the false doctrines with one voice, there is obviously an urgent need for co-operation between the followers of several disciplines, and their deliberations should also indicate a long-term policy of popular education. Marx House is to be congratulated on having encouraged scientific men to abandon their ostrich-like attitude to these matters.

GENETICS AND THE RUSSIAN CONTROVERSY

By DR. K. MATHER

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A CALL to reject in its entirety forty years work in a science which has engaged widespread attention and earned distinction for many, including a Nobel laureate, is both very unusual and very disturbing. Yet this is what Lyssenko and his followers at the Russian Genetical Conference of 1939 would have us do[1]; and, what is still more disturbing, no one other than those directly engaged in genetical research has found it desirable actively to oppose Lyssenko's views. Indeed his allegations have been repeated, and, it would appear, supported, in Great Britain[2].

The situation so created cannot lightly be dismissed by geneticists as the failure of others to appreciate the fundamentals of their subject. It is true that many of the charges are based on a misunderstanding of genetics and its theory, but we must inquire into the reasons why such a misunderstanding can exist. The study of inheritance must have attracted the sympathetic interest of many biologists, especially those engaged in evolutionary studies and the improvement of crops and stock. Yet genetics has apparently proved so disappointing that they do not feel sufficiently concerned to protest at Lyssenko's attack. This implies a sense of frustration, and in order to see how such a feeling could arise, side by side with the rapid development of a sound genetical theory, it is necessary for us to examine the progress of genetical science during its forty years of active propagation.

Gregor Mendel formulated two laws of heredity from which our theory of particulate inheritance has developed[3]. But to do so he devised an experimental technique for investigating genetical differences, and this is, perhaps, his major achievement. Without the technique he could not have made his own discoveries. With the technique he could solve his problems and, what is more, later geneticists could test, modify and extend his laws into the modern theory. Mendel's technique ensured the development of genetical science.

Now this technique of Mendel's depended on the use of single differences. He treated the differences between tall and dwarf, between round and wrinkled seeds. Only when he understood their individual behaviour did he proceed to investigate joint segregations. Once the 3 : 1 single-factor ratio was understood, the 9 : 3 : 3 : 1 and 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1 could easily be interpreted. Thus his success depended on treating the simplest cases first. It is even clearer that the successful analysis of factor interactions, characteristically modifying the 9 : 3 : 3 : 1 into 9 : 7, 15 : 1, 12 : 3 : 1, 9 : 3 : 4 and so on, was impossible until both single-factor and two-factor segregation was fully understood.

Carried to its conclusion this process of investigating segregations of steadily increasing complexity would have led to an attack on the problems raised by those characters, like stature in man, which can only be interpreted as under the control of many genes, and which are hence termed polygenic. The task would have been more formidable than most early Mendelian researches, for these polygenes have individual effects which are small when compared with non-heritable fluctuations. That the approach was, however, then contemplated we may infer from Nilsson-Ehle's discussion of duplicate and triplicate factors in cereals[4]. Furthermore, Emerson and East soon afterwards published a paper on polygenic inheritance in maize[5], and their example was copied by a few other geneticists. But it happened that circumstances, which we shall discuss in a moment, directed interest into other channels. This was the beginning of loss of touch between genetics and the other branches of biology mentioned above; for evolutionary change, as well as the improvement of crops and stock, depends on these complex characters. Species differences and the commercial qualities of plants and animals are polygenic, and it is polygenic, not simple, inheritance which evolutionists and breeders wish to see analysed.

Why then was the attention of geneticists directed elsewhere? There were several contributory reasons. Mendel was not the first man to investigate inheritance, and when his work was re-discovered at the beginning of this century investigations of a different kind were being actively pursued. Galton and Pearson had attempted the analysis of polygenic inheritance, especially in man, by methods quite unlike those of Mendel, and their conclusions were also quite divergent from Mendel's[6]. Thus with Pearson defending biometry and Bateson advocating Mendelism a feud arose, and to geneticists polygenic inheritance assumed a heretical appearance. In the second decade of the century a few geneticists, notably Emerson and East[5] and Fisher[7], showed that the biometrical results could be interpreted as due to the action of many factors behaving in the Mendelian way, but their findings aroused little enthusiasm either in the biometricians or in the Mendelians, who had been, in Great Britain at least, antagonistic for many years. Thus we see that the first reason for the failure to press polygenic analysis was that it had become somewhat improper in the eyes of geneticists.

The second reason was that polygenetics had technical difficulties. Sharp segregations are never shown by polygenic characters and so their analysis requires a combination of genetical and statistical techniques, such as was not then available. If of course interest and enthusiasm had been sufficiently great we may be sure that the necessary technical advances would have been made; but, in point of fact, we can find no contribution to the combination of genetical and biometrical techniques before that of Fisher, Immer and Tedin in 1932[8]. Genetical theory had by this time developed to a stage at which polygenic analysis of a kind impossible fifteen years earlier could be attempted, but slight use has since been made of the methods of these authors. Indeed there is little reason to believe that even to-day the full technical equipment for polygenic analysis is available. Perhaps no single method will be adequate, though selection experiments have proved of considerable value from the time of Johannsen[9] up to the present[10].

In the meantime Mendel's methods had, in Drosophila, led to an astonishing series of advances. Bateson and Punnett discovered, in 1906[11], that unit factors do not always segregate independently. Sex linkage was found shortly afterwards, and the field was clear for the proof of the chromosome theory of heredity, with all its corollaries, when Morgan and his associates began to apply the back-cross technique to *Drosophila melanogaster*. In a very few years sex linkage, the linear order of the genes, non-disjunction of chromosomes, crossing-over and sex balance had all been investigated by this method, and shown to be attributable to the special properties of chromosomes[12]. Here we have the greatest reason of all why polygenetics was neglected. Its technical difficulties stood in such sharp contrast with the basically simple and highly fruitful methods of the 'Drosophilists'. The trickle of papers on polygenic inheritance which had appeared after 1910 almost ceased when the full value of the Drosophila research was apparent to all. Instead similar work was undertaken in maize and other plants, in some cases by the few who had a short time earlier been pursuing polygenic studies.

The first phase of Drosophila genetics was as good as over by 1925 when triploids and attached X females had been investigated. It appeared about this time that interest in polygenic behaviour might be revived by the use of marker genes for the sorting out of complex genetical variation in terms of the chromosomes. In fact one paper of this type, on egg size in Drosophila, appeared in 1924[13], but a new departure in genetical research put paid to this promise. In 1927 Muller[14] announced his discovery that gene mutation could be induced by X-ray treatment and so started a line of investigation which is still being actively pursued. This was followed by Darlington's re-casting of cytology in an inductive-deductive form in the early 1930's[15], by the use of the giant salivary gland chromosomes by Painter in 1934[16], and by Beadle and Ephrussi's investigations on gene action in 1935[17]. Polygenic characters seemed to have sunk completely out of sight under this competition.

Interest was, however, to be revived once more by the turn which genetics has taken towards the experimental study, as opposed to theoretical discussion, of evolution during the last ten years. Though at first attempted by the use of the familiar major mutations this departure forced geneticists to the conclusion that species differences are polygenic (see Timoféeff-Ressovsky and Muller[18]). The stage is again set for an attack on this complex type of inheritance, and, as result of the extra power given to genetical analysis by the chromosome theory and by Fisher's statistical techniques, the opportunity is greater than ever before. Let us hope that it will be seized.

During these forty years of consistent failure to get to grips with the type of inheritance which is, above all others, of importance to evolutionists and breeders, geneticists have not been slow to point out that their science is basic to the practice of research in these other fields. Much of the discussion has been valuable. The theory developed by Fisher, Haldane and Wright has cleared the ground for the new genetical research on problems of evolution, and Timoféeff-Ressovsky, Sturtevant and Dobzhansky have already shown what can be accomplished. But much of the genetical discussion has been unfortunate and harmful, especially in the absence of any experimental results. Though the later geneticists interested in the question have been, to a man, Darwinists, the earlier writers, notably Bateson[19] and de Vries[20], have left a deep mark on the attitude of the average biologist towards genetics, because they continually emphasized the sharply discontinuous nature of variation, when the practical examples of discontinuity to which they could point were generally mutations which appeared, to all but the geneticist, to be almost pathological in their effects on the organism's viability. Here we can see the origin of Lyssenko's attack.

Mendel's discoveries appeared shortly after the "Origin of Species", and we may take it that they would have profoundly affected Darwin's later work if he had been familiar with them. Fisher[21] has shown that the particulate theory of inheritance provides the solution to Darwin's most troublesome difficulty, that of seeing how the store of variability, which Darwin took to be blending, was saved from rapid decay. Darwin accepted this rapid decay and sought to overcome the trouble by assuming an equally rapid replacement by new, or, as we should say, mutational, variation, under the stimulus of novel environmental conditions. This view he developed in "Animals and Plants under Domestication", which Mendel's findings rendered unnecessary as a central part of the theory of evolution. It is thus necessary when discussing genetics and Darwinism, to state which Darwin is concerned, the author of the "Origin of Species" or the author of "Animals and Plants". Genetics is wholly consistent with the "Origin of Species" but has little concern with "Animals and Plants", which in its turn is unnecessary for evolutionary theory.

This effect of particulate inheritance on Darwinian theory was, however, overlooked in the early years of the century. Mendel's paper was re-discovered at a time when small apparently continuous variations were being decried and the younger biologists, of whom Bateson was one, were turning to the view that the variation from which evolutionary change flowed was sharply discontinuous. Mendelian segregation and de Vries 'mutations' in Œnothera apparently fitted so well to this view that they were immediately seized on as good evidence in its favour. It was only much later, when the true nature of de Vries mutations was known[15], and the effects of natural selection on major genes had been considered, that the superficial nature of this evidence was realized. The return to Darwinism and polygenetics then became inevitable. The speculation of Bateson, de Vries and their followers was vitiated by their failure to assess accurately the evolutionary significance of the major variants which they observed, and there was insufficient experimental information to provide an adequate check on this speculation. It is now clear that discontinuous genotypical variation is not incompatible with continuous phenotypical variation; when each of the many genes has a small effect and non-heritable fluctuations occur. Polygenetics integrates genetical discontinuity and Darwin's smooth variation. Bateson and de Vries failed in not seeing that such an integration was possible.

We are now in a position to see Lyssenko's charges in their true perspective. We are not immediately concerned with the method of plant breeding that he advocates. If it should prove sound, its basic theory must be incorporated in genetics; but this is a matter for the future, and in the meantime cannot affect our judgment on his specific charges against genetical theory.

When Lyssenko states that genetics has not contributed very much to the improvements of crops and stock, we must agree with him. In special cases, like the development of autosexing poultry, genetics has been of great value, but these cases are exceptional. The reason for this failure is not, however, that genetics is unsound, but that its development has, owing to a series of historical accidents, been away from the breeders' problems. This may be deplorable, but it provides no ground for pessimism about the contribution that suitable genetical research can make to breeding technique. To deny the potential value of genetics would be as great a misjudgment as that of any geneticist who tried to maintain that his subject had, in the past, given results on which all breeding work must be based. The reality of the present lack of touch is well shown by the way that, at the Russian conference, the bearing of genetics on breeding technique became a matter of personal testament rather than one of analytical discussion.

Secondly, when Lyssenko holds that genetics is anti-Darwin, he is wrong, at least as regards the "Origin of Species", though when he maintains that geneticists have been anti-Darwin he is obviously right. In the absence of appropriate experimental work, the relation of genetics and evolutionary theory has been a subject for unchecked speculation of which much was superficial and unsound. Perhaps the best evidence of the soundness of the genetical approach, as distinct from genetical speculation, is that, in spite of the lack of polygenic research and in face of the utterances of the early Mendelians, geneticists are to-day realizing more and more that small variations are the material of evolution;

though they realize equally that Darwin's argument in "Animals and Plants" is not essential to the theory and may be removed without weakening the general structure in any way.

Finally we come to Lyssenko's condemnation and rejection of what he calls "Morganism-Mendelism". We can see that it arises from a failure to realize the relations of genetical development and the breeder's requirements. He says, in effect, that genetics is useless to the breeder and therefore should be abolished. But astronomy is of no great use to the breeder and yet we do not consider abolishing that science. The real situation is that the particulate and the chromosome theories of heredity are founded on a vast body of fact. They have been tested and re-tested, but never found wanting. Nor has Lyssenko himself any evidence of their alleged unsoundness, though he may have plenty of their faulty interpretation by geneticists themselves and by others. As a case to point, we may take his rejection of pure-line theory on the basis of his observation that intravarietal variation exists in self-fertilizing cereals. The existence of such variation cannot in fact vitiate pure-line theory. Indeed Johannsen himself envisaged this very type of variability[22]. It does, however, show that the application of the theory was faulty because, as Lyssenko discusses it, both mutation and the small amount of out-crossing, known to occur in wheat, oats, etc., are overlooked. It is to the investigation of these agents that attention should be turned, rather than to the alleged unsoundness of misapplied genetical theory.

To call for the rejection of genetical theory is useless; for this theory is sound, no matter how disappointed we may feel that, while developing its internal structure, genetics has neglected those aspects which appeal to the breeder. What is required is experimental research on polygenic behaviour, so that genetical theory may be enlarged until the full potential value of genetics to evolutionist and breeder is realized. The task will doubless be laborious, but the need is obvious and the opportunity great.

[1] Reported in "Pod Znamenem Marxisma". Translation available at the offices of the Society for Cultural Relations, 98 Gower Street, London, W.C.2.

[2] 'Espinasse, P. G., NATURE, **148**, 739 (1941).

Mendel, G. J., Translation in Bateson's "Mendel's Principles of Heredity" (1865).

[4] Nilsson-Ehle, H., "Kreuzunguntersuchungen an Hafer und Weizen" (Lund, 1909).

[5] Emerson, R. A., and East, E. M., Neb. Agric. Exp. Sta. Res. Bull., **2** (1913).

[6] Galton, F., *Proc. Roy. Soc.*, **61**, 401 (1897).

[7] Fisher, R. A., *Trans. Roy. Soc. Edin.*, **52**, 399 (1918).

[8] Fisher, R. A., Immer, F. R., and Tedin, O., *Genetics*, **17**, 107 (1932).

[9] Johannsen, W., "Elemente der exakten Erblichkeitslehre" (Jena, 1909).

[10] Mather, K., *J. Genet.*, **41**, 159 (1941).

[11] Bateson, W., and Punnett, R. C., Rep. Evolution Comm. Roy. Soc., III (1906).

[12] Morgan, T. H., Sturtevant, A. H., Muller, H. J., and Bridges, C. B., "The Mechanism of Mendelian Heredity" (New York, Holt, 1915).

[13] Warren, D. C., *Genetics*, **9**, 41 (1924).

[14] Muller, H. J., Verh. V. int. Kongr. Vererbungsw., 234, *Z.I.A.V. suppl.* I (1927).

[15] Darlington, C. D., "Recent Advances in Cytology" (London, Churchill, 1932).

[16] Painter, T. S., *Genetics*, **19**, 175 (1934).

[17] Beadle, G. W., and Ephrussi, B., *Proc. U.S. Nat. Acad. Sci.*, **21**, 642 (1935).

[18] Huxley, J. S. (ed.), "The New Systematics" (Clarendon Press, Oxford).

[19] Bateson, W., "Mendel's Principles of Heredity" (Cambridge University Press, 1909).

[20] de Vries, H., "Die Mutationstheorie" (2 vols.) (Leipzig, Veit, 1901–3).

[21] Fisher, R. A., "The Genetical Theory of Natural Selection" (Clarendon Press, Oxford, 1930).

[22] Johannsen, W., *Amer. Nat.*, **45**, 129 (1911).

ROLE OF PHOTOGRAPHY IN THE DETECTION AND MEASUREMENT OF RADIATION*

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LIGHT which falls on a photographic plate causes the crystals of silver halide, which form the essential constituent of the sensitive layer, to be converted by subsequent development to silver grains, and gives rise to a blackening of the exposed areas. The silver grains can be counted under the microscope, but they provide no direct measure of the incident energy. Although much painstaking work, culminating in the recent theory of Gurney and Mott, has led to a fairly complete understanding of the mechanism of the photographic process, many factors enter in to prevent the establishment of a one-to-one, or other simple, relationship between silver grains and absorbed quanta. Thus the photographic plate cannot be used as a method of absolute measurement of radiation: like the part played by the eye in visual photometry, its role is that of a null instrument for the measurement of an unknown source of radiation by comparison with a known. In addition, and unlike the eye, it provides a permanent record of brightness variations, often over an extended field.

How the photographic plate compares in sensitivity with the eye is a question often asked, and one to which no simple answer can be given. Objects of sufficient brightness to be seen at a glance require an exposure of several minutes to be recorded when a photograph is taken using lenses at present available; yet the existence of distant nebulæ is known only through the use of photography. The photographic plate can integrate radiation falling on it over long periods of time, and it is this ability which constitutes one of its greatest advantages, notably in stellar photography and astrophysics. Moreover, it can be used over a far greater wave-length range than the eye; the recording of ultra-violet lines of spectra provided one of its earliest triumphs; its sensitivity extends into the infra-red; and the great convenience of obtaining a record of the many lines of a source, which may be varying rapidly in intensity, has caused the almost universal use of photography in spectroscopy. X-rays were discovered by their action on the photographic plate, which is sensitive also to γ-rays, cosmic rays, electrons and nuclear particles. Over this wide range, comparative intensity measurements can be made. The accuracy attainable depends on the physicist's knowledge of the characteristics and behaviour of the photographic material and on his ingenuity in devising methods which reduce to a minimum the effect of the many possible sources of error. Under favourable conditions, accuracy of the same order as that possible in visual photometry can be obtained.

The light-sensitive unit is the silver halide crystal. The crystals are usually silver bromide, or mixed crystals of silver bromide with a small percentage of silver iodide, and are of the order of a micron in size. After exposure to light they suffer no visible change, but the affected crystals are completely converted to metallic silver by immersion in certain

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[*] Substance of a lecture delivered to a joint meeting of the London and Home Counties Branch, Institute of Physics, and the Royal Photographic Society on Feb. 24.

reducing solutions known as developers, and are said, therefore, to contain a latent image. Since the conversion of any crystal to silver is complete, it is not surprising that the fastest photographic materials are those with the largest crystals; but departures are found, and size is not the only determining factor in sensitivity. The silver halides are conductors of electricity. In the dark the conductivity is ionic: it is temperature-sensitive, and at low temperatures falls to zero. On exposure to light there is conductivity at all temperatures, caused by the liberation of electrons; these tend to congregate at any point of low potential energy and to set up a field. Interstitial silver ions, which, ejected by thermal agitation from their lattice position, are responsible for the ionic conductivity, are attracted to the point and form there a speck of silver. This is the latent image which catalyses the process of development.

Thus, sensitivity depends upon the presence of nucleating centres in the crystals before exposure. Without these centres, which are produced in the course of manufacture and are believed to consist of minute traces of silver sulphide, the halide crystals are comparatively insensitive. It is this two-stage process in the formation of the latent image—the release of electrons and the subsequent attraction of silver ions—which is responsible for many of the complex phenomena that are observed. Any radiation that is absorbed will cause the formation of a latent image. The natural absorption of silver bromide is restricted to the blue and ultra-violet, where it is finally limited by the absorption of the gelatin in which the crystals are suspended. The addition of traces of sensitizing dyes results in the formation of a monomolecular coating of the crystals, and the energy absorbed by the dyes is passed on and utilized; in this way the sensitivity has been extended to a wave-length of $1{\cdot}3\mu$; theoretical considerations indicate that an upper limit will be set at about 2μ by thermal energy. The number of quanta required to produce a latent image is not known with any certainty; it probably varies from a few to many hundreds; and the crystals are found to vary widely in sensitivity even when their size is constant, an effect attributable to the need of a suitable nucleating centre. By comparison, high-energy quanta, X-rays, electrons, etc., appear to cause developability upon a single impact.

The photographic effect is conveniently measured by the density of the layer after development and drying. This is defined as the common logarithm of the reciprocal of the transmission, and bears no simple relationship to the number of grains, depending as it does upon size of the grains and upon the method of measurement. Although the silver grains are black, they scatter light appreciably; and the measured density depends to a considerable extent upon the proportion of the scattered light which is collected by the measuring instrument. The effects of exposure and development are usually represented by plotting the density as a function of the logarithm of the exposure; this results in the well-known S-shaped characteristic curve. The position of this curve with respect to the logarithm of exposure axis represents the 'speed' of the photographic material.

Since different materials differ also in the shape of their characteristic curves, the measurement of speed depends to a great extent upon the convention adopted; the choice will be governed by the purpose for which the measurement is required; in spectrography, for example, the reciprocal of the exposure to produce a density of 0·6 is often taken as a convenient measure. The slope of the curve determines the ability of the plate to reveal small object brightness differences; and, by the use of recording materials of high 'contrast', differences of brightness which are invisible can be readily recorded. The shape and position of the curve depend both upon the conditions of exposure and of development, so that it is characteristic of the photographic material in only a limited sense. With increase in the time or temperature of development, the curve increases in slope and tends to shift laterally towards lower exposure values as more and more grains become developed: in general, both contrast and speed increase.

Change of absorption with wave-length can cause the slope of the characteristic curve to change; exposure to ultra-violet light, which is strongly absorbed, leads to curves of much lower slope. The time of exposure is a factor of great importance. The photographic plate is not a perfect integrator of radiation: an x-times reduction in intensity cannot be made up for by an x-times increase in exposure time. Thus intensity and time are not reciprocal quantities, and the photographic plate is said to show failure of the 'reciprocity law'. If, therefore, the logarithm of the exposure (intensity × time) necessary to produce a given density is plotted as a function of exposure time, instead of a horizontal straight line being obtained, the curve passes through a minimum, which, with many materials, occurs at times of the order of 1 second. At both shorter times (higher intensities) and longer times (lower intensities), more exposure is necessary to produce the given result.

These departures, which are of great importance in many problems of photographic photometry, are the direct result of the two-stage formation of the latent image. At high intensities, the second stage—the moving up of the silver ions—does not take place quickly enough; the capacity of the nucleating centres for electrons is limited; some are repelled before they are neutralized by the silver ions, and the size of the silver speck is therefore reduced. At low intensities, the nucleating centres build up slowly: in the early stages of their growth they are not stable and tend to lose electrons by thermal agitation; considering the same total number of quanta incident on a crystal, the greater the rate at which they are received the greater their effect. In the extreme case, unless the rate of reception of quanta is more than sufficient to counterbalance the loss by thermal agitation, no duration of exposure will give a photographic effect. Thus, in astronomy, success depends upon the size of the telescope used, since this governs the brightness of the stellar image; prolonged exposure with small telescopes fails to reveal the fainter stars detectable by larger instruments. The shape of the so-called reciprocity curve can be modified in several ways. If the temperature is lowered during exposure, the mobility of the silver ions is decreased and the sensitivity at high intensities is thereby decreased, but at low intensities the sensitivity is increased, since the latent image becomes more stable. Use has been made of this effect in astronomy, and plates have been cooled to a temperature of solid carbon dioxide during exposure in order to increase their sensitivity.

The addition of a uniform exposure has interesting and useful results. The sensitivity of the plate may be increased either by a uniform exposure before the camera exposure or after it, depending upon the actual time of the camera exposure; when this is long, as in the photography of faint celestial objects, the sensitizing exposure must take place beforehand and must consist in a short flashing of the plate; when the camera exposure is relatively short, the uniform exposure must follow and must be to a low intensity for a long time. In either case, the added exposure is adjusted in amount to produce only a small general fogging which does not greatly affect the interpretation of the record. Uniform after-exposure or pre-exposure can thus be useful, if applied deliberately; but equally they may lead to serious errors if they occur accidentally and pass unrecognized.

A manifestation of reciprocity failure that has long been recognized as a source of error in photographic photometry is the intermittency effect: an exposure given intermittently may produce a greater, or lesser, density than when the same total exposure is received continuously. Quite recently it has been shown that, if the interruptions are sufficiently rapid, the effect is the same as that produced by a continuous exposure of an intensity equal to the *average* intensity of the intermittent exposure. The frequency of interruptions must be so high that on the average each grain receives only one quantum during each separate exposure. Owing to the small size of the grains, the critical frequency is not as high as might be imagined: an exposure of one second duration need be interrupted at a rate of only a hundred per second. From being a source of error, valuable use can now be made of the effect: by rotating sectors at high speed, variations in time can be converted effectively into variations in intensity. Apart from the occasional advantages that can be made of these effects of reciprocity failure, the fact of importance in photographic photometry is that the calibrating exposure should always be of the same duration as the exposure to the unknown source. There are only two exceptions to this rule: X-rays, and other high energy quanta, because they make a grain developable by a single impact, show no reciprocity failure; the log It/log t curves for different wave-lengths are always parallel. If, then, during the process of calibration, one spectrum line is reduced in intensity until it matches in density another line of the same spectrum, the relative energy of which is known, the result will be independent of the exposure time; so that, in certain cases, the calibrating exposure need not be of the same duration as the unknown.

The general rules of photographic photometry follow readily from what has been said. The calibrating exposure should always be impressed on the plate used for recording the unknown radiation, so that errors of development may be reduced. Whenever possible, the two exposures should be made on contiguous areas, since the plate may show small local variations in sensitivity. The spectral composition of the calibrating radiation should be identical to that of the unknown radiation, although in spectrophotometry within narrow spectral regions it is permissible to use a mean wave-length for the calibrating radiation, for example, by the use of sharp cutting filters. The time of exposure must be the same for both exposures, apart from the two exceptions mentioned.

It has been assumed that the exposed areas are large and that edge effects can therefore be neglected: the sensitive layer has been imagined to be a two-dimensional continuum, and any effects caused by its finite thickness have been ignored. During the course of manufacture, the photographic 'emulsion', which is a suspension of silver halide in a solution of gelatin, is coated evenly on to its support, and dries down to form a layer about one thousandth of an inch in thickness. During development, the layer swells to some five times this thickness. The images to be recorded are often of comparable dimensions, for example, the image of a star or of a spectral line; and second-order effects arise, owing both to the penetration of the light and the penetration of the developer. The light is strongly scattered on entering the layer, and a sideways spreading of the image results: the developer solution reaches the grains by diffusion, and the products of the chemical reaction diffuse outwards; they inhibit the reaction and produce local variations which may sometimes cause the density distribution of an image to depart seriously from its true form. Full development and vigorous agitation of the developing solution over the surface of the plate will generally reduce these effects to negligible proportions; but the effect of light scatter is not so easily overcome. Use can sometimes be made of this, as in astrophysics, where the growth of the image with exposure is used as a measure of stellar magnitude. More often the scatter tends to destroy the fine detail of the image, and can be limited only by the best choice of materials. The effect depends both on the grain size and the number of grains per unit volume of the layer, as well as on the wave-length of the light; and the finest grain emulsions are not necessarily those which scatter least. The discrete nature of the developed image also plays a part in the detection of fine detail. A microdensitometer record of a uniformly exposed and developed area shows irregularities caused by this granularity of the image; variations due to this cause will be superimposed on those which are the subject of investigation, and will tend to mask them. The graininess increases both with the density of the image and with the size of the grains; its effect on visibility tends to outweigh that of light scatter, so that slower emulsions almost invariably have greater resolving power than faster ones. An additional reason is that slower emulsions generally have higher contrast, and this naturally increases the ability to differentiate small brightness differences.

It is not surprising that an almost bewildering array of photographic materials is available. The choice must depend upon the problem in hand. Sometimes the need is for high resolving power and for low graininess; at other times, these desirable features must be sacrificed for extreme speed for some part of the spectrum; and consequently a compromise must usually be made.

OBITUARIES

Prof. A. W. Nash

ALFRED WILLIAM NASH, professor of oil engineering and refining at the University of Birmingham, died in his fifty-sixth year at his home in Solihull on March 14. After training as a mechanical engineer at King's College, London, he had some experience in dock construction in Hong-Kong, and shortly afterwards joined the (then) Anglo-Persian Oil Company and took part in the building of the great refinery in Abadan, South Persia. In 1913 he proceeded to the Caucasian oil territory and remained in Russia for more than five years, chiefly engaged in field production problems.

Then began Nash's long and successful career in Birmingham in the footsteps of that great pioneer, the late Lord Cadman, who had founded the first school of petroleum technology in Great Britain under his charge as professor of mining. When Cadman left, the chair was divided and a separate professorship of oil technology was established, and in 1924 Nash was appointed to the post. A very substantial endowment of £125,000 had been raised by the great British oil companies, and Nash's first task was to erect a block of laboratories, offices, museum and library to house his school. This was opened in 1926 and remains as his chief monument.

During his whole career in Birmingham, Nash was responsible for a constant stream of scientific contributions to oil technology. He was a man of ideas and well able to stimulate his staff and students. With his ample background of first-hand experience in oil-fields and refineries, he was well equipped to sense the relative importance of both practical and academic problems, and to direct a vigorous and progressive school of research, while in the course of his many visits to centres of oil activity in America, Europe and the East he made innumerable contacts with the men on the spot, and thus realized the need for investigation on this or that project.

Throughout his active life he was intimately concerned with the affairs of the Institute of Petroleum —known, when he became a member in 1914, as the Institution of Petroleum Technologists. For many years he served on the Council and as vice-president; three years ago he was elected president, and he died in that office. Most of his contributions to science are to be found in the pages of its *Journal*, but he was a prolific worker, and many of his papers appeared in American technical journals.

In collaboration with his colleague Dr. Bowen he wrote "The Principles and Practice of Lubrication"; with Dr. D. A. Howes, "The Principles of Motor Fuel Preparation and Application"; and he played a great part in the organization and editing of the four volumes of "The Science of Petroleum". His work with Howes on knock-rating of pure hydrocarbons was of great merit; he demonstrated the synthesis of lubricants from the simple olefines by polymerization; with Hunter he developed the fundamental study of solvent extraction, the dewaxing of lubricating oil and the refining of waxes. With Dr. A. H. Nissan he published a valuable paper on the relation between viscosity and constitution. His presidential address on "Petroleum as a Raw Material" showed real insight into the ever-growing utilization of oil and its gaseous by-products as raw materials for chemical syntheses.

This brief note would be very incomplete did I not pay a personal tribute to my old and valued friend and collaborator. Nash had a most lovable nature, and those of us who enjoyed his close friendship for many years feel his passing acutely. Especially will he be missed by his old students who, working in all parts of the world, always kept in touch with him, and were always delighted to visit him on their return home.

A. E. Dunstan.

We regret to announce the following deaths:

Dr. B. M. Griffiths, formerly reader in botany and head of the Department of Botany in the University of Durham, on March 25, aged fifty-five.

Mr. R. W. Haydon, formerly lecturer in agriculture, University of Leeds, on March 28.

Mr. H. J. Hughes, formerly principal of the Muresk Agricultural College, Western Australia, on September 27, aged sixty-seven.

Dr. T. B. Macaulay, formerly president of the Sun Life Assurance Company of Canada, founder of the Macaulay Institute of Soil Research at Aberdeen, on April 3, aged eighty-one.

Mr. F. J. Rae, director of the Melbourne Botanic Gardens and Government botanist for Victoria, on September 18.

Mr. L. Wray, I.S.O., formerly director of the State Museums, Malaya, on March 14, aged eighty-nine.

NEWS and VIEWS

India

The breakdown of the negotiations conducted by Sir Stafford Cripps on behalf of the British Government with the chief Indian communities for a settlement of relations between the British and Indian peoples is a cause for profound regret. At a time like the present, every jarring note in the concord of the free nations is eagerly awaited in the Axis camp, and is represented by every device of propaganda as a major disaster. This it certainly is not, for although the leading communities in India have been unable to agree either among themselves or with the British Government on any immediate change in the form of government of the country, on the major issue, namely, resistance to aggression, there has been striking agreement. Further, the various parties have been able to put their views to a member of the British Cabinet, and have themselves been able to study concrete proposals for a settlement. The fundamental stumbling block is clearly lack of mutual understanding and sympathy, and, one fears, an under-estimate of the complex factors involved in ruling a sub-continent. The old divisions and the old distrust are still painfully apparent. As Sir Stafford Cripps said in his farewell broadcast to the Indian people: "Someday, somehow, the great communities and parties in India will have to agree upon a method of framing their new constitution". The problem will have to be approached in the scientific manner, assembling all the data and weighing them without prejudice, in the sure hope that a true solution will eventually be found.

Science and Ethics: A Hindu View

The symposium on science and ethics, opened by Dr. C. H. Waddington, which appeared in these columns during September and October of last year, aroused world-wide interest. We have already published a communication from Prof. Chauncey D. Leake, who was chairman of a discussion on the same topic by American biologists; and we hear that the Aristotelian Society is arranging a meeting early in June at which Dr. Waddington will be invited to defend his views. A comment on the symposium by D. V. Gundappa was published in the Indian journal *Current Science* in December last, and a revised and enlarged reprint of his remarks has just reached us. Mr. Gundappa emphasizes the lack of agreement between the contributors to the symposium, and states his own view "that the data which science in its present state can furnish . . . for a theory of ethics or metaphysics are a field of quicksand". He then presents an extremely valuable summary of the Hindu philosophy of ethics, which, as he rightly points out, is only too little understood in Great Britain. Its elaborate structure and the mystical nature of its concepts will probably always make it difficult for non-Hindus to comprehend, but Mr. Gundappa's account, which is short and admirably clear, should serve as a most useful introduction to this important phase of human thought.

Federal Union and Peace Aims

WRITING with reference to recent articles in NATURE on reconstruction, the Federal Union Ltd., 3 Gower Street, London, W.C.1, has forwarded to us a resolution relating to the "Peace Aim—War Weapon" report prepared by its Peace Aims Committee, and passed by representatives of 150 branches of this movement at the annual general meeting held at Eastertide. The resolution reads: "Lack of unity among the United Nations can lose both the war and the peace, and we therefore call upon the Government to cement their unity by the following methods: (1) Inviting Russian and Chinese representation on the joint commissions directing Anglo-American strategy and supply. (2) Pressing our Allies to set up an Allied Political Warfare Board. (3) Appointing an Allied Reconstruction Commission whose task would be to draw up a draft treaty outlining the world organization which should arise out of this war; this treaty to include plans for a nucleus democratic federation open to the members of such a world organization. The Allied Reconstruction Commission should define in a Twentieth Century Charter of Rights the political and social objectives which must be the foundation of both world organization and democratic federation. (4) Setting up, in conjunction with those of their Allies which have democratic governments in control of their countries, an International Consultative Parliament to advise the various Governments on the conduct of the war and to draft a provisional federal constitution."

Books for Damaged University Libraries

THE Committee on International Relations of the British Federation of University Women, at present at 16 King Street, Reading, Berkshire, points out that during the present hunt for salvage many books and journals are being sent for pulping which would yield only a small contribution to the War effort but a much greater contribution to the restoration of universities. The British Federation of University Women is therefore trying to collect books and journals suitable for academic libraries. The Committee would like to have particulars of suitable books and spare sets, volumes, or even odd numbers of scientific and similar journals. If possible, the Committee would like the donors to keep these books until the end of the War, as it is safer to have them dispersed, but depots will be arranged if necessary to which the books may be sent. The British Federation of University Women hopes by these steps to be ready, when peace comes, to help fill the many gaps made in university libraries in Great Britain and elsewhere by enemy action; this would be an important step in the reconstruction of university life.

Feeding Factory Workers in the United States

THE Council on Foods and Nutrition and the Council on Industrial Health of the American Medical Association have condemned the indiscriminate giving of vitamin pills to factory workers. They state that at the present time there is no body of scientific information on which to base the recommendation that industry as a whole adopt such a practice, which is irrational from the therapeutic point of view, unwise from the nutritional point of view and uneconomical; instead, firms should support research on nutrition among their workers. The Councils recommend a balanced diet of natural foods, and it is stressed that calories are the most important consideration. "No amounts of vitamins and essential mineral nutrients can obviate this need for energy. Furthermore, if wholesome natural foods are used as the source of the needed calories, the required vitamins and minerals will be secured automatically because they are contained in these natural foods." Reference is made to the stress laid in Great Britain on the provision of factory canteens where at least one good meal each day is provided; it is suggested that employers avail themselves of accurate data on diet from authorized Federal or State agencies, and, under proper direction, teach individual workers the bases of nutrition and through them their wives. The report closes with a reminder that nothing in the Councils' statements is intended to belittle the significance of vitamins in nutrition, or the value of the proper use of added vitamins in improving staple foods such as bread and flour.

Technically Trained Chemists in the United States

THE Defense Committee of the American Chemical Society has issued a report on a survey of one hundred and eighteen colleges and twenty-nine chemical corporations in the United States in connexion with the American war effort. It is reported that essential industry needs in 1942 from 2,000 to 3,000 more chemists and chemical engineers than will be graduated or are otherwise available. The official statement reads: "The Army and Navy are deeply concerned. Investigations made by this organization prove that trained personnel to produce this material [munitions] is lacking. Not only the finished product but also the raw material going into smokeless powder, rubber, etc., can be produced only under the active control of experienced chemists and chemical engineers. There is far greater immediate danger to the ultimate outcome of the war from shortages of such man-power than there is from any lack of officers and men in the combat force. Without production of essential materials the war will be lost, since the combat forces can not exist without material."

Earthquake in New Guinea on January 27

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has provisionally determined the epicentre of the earthquake of January 27 last, which occurred at 13h. 29·4m. U.T. The determination was based on instrumental reports from seismographic stations at St. Louis, Tucson, College, Logan, San Juan, Pasadena, Philadelphia, Lincoln and Fordham. The epicentre appeared to be in the region of Geelvink Bay in western New Guinea. The region of and around New Guinea appears to contain, in addition to active centres of activity, both active and semi-active volcanoes. An earthquake with epicentre some two miles south-east of Rabaul (New Britain) occurred on May 7, 1919, in the neighbourhood of the semi-active volcano Glaie or Tavurur. One previous to this was on January 1, 1916. The line of disturbance is south-west from the volcano Glaie to the large active volcano called the Father on the north coast of New Britain. Earthquakes appear to be most severe when the Father is quietest. The line extends then westerly towards the west end of New Britain, where there are semi-active volcanoes; thence on to the island of Manam off the coast of New Guinea, where there is a very active volcano. The present seismic activity appears either to be on another branch of this line of activity, or along a westward extension of the line.

Earthquake in the Philippines

An earthquake of considerable severity was registered at both the Riverview and Perth Observatories in Australia on April 9 early in the day. At Perth the seismograph pendulum boom swung five inches, and at Riverview the seismograph showed earthquake waves passing the observatory for four hours. It was tentatively suggested that the earthquake might have had its epicentre under the sea south-west of Luzon in the Philippines.

Rainfall Flooding and Health

A Chadwick Lecture under the Bossom Gift was given on April 14 by Mr. D. C. Graham, who discussed the dangers from rainfall in urban areas, the prevention of flooding of buildings and of its insanitary consequences. Mr. Graham dealt with the subject under four headings: (1) faulty design of buildings and omissions of essentials; (2) overflowing of streams and rivers; (3) damp and flooding by land water; (4) backing up of rainwater in drains and sewers. The first two causes were touched on and the two last discussed in detail. Reference was made to the importance of the building by-laws in this connexion and to the necessity of careful inspection and repair of river walls. As regards the third cause, there is considerable difficulty in ascertaining in dry weather whether a building site will remain dry and whether there are any land drains or filled-in ditches that will cause dampness or flooding after heavy rain. The varying levels of the land water due to drought, pumping near the site and to wells and the great importance of constructing the lowest floors of building either above the maximum water level or making the walls and floors waterproof and of sufficient strength, were dealt with, as well as the aying of sub-soil drains near a building, and what hey should and should not do. It is not practicable or financial and other reasons to provide sewers of ufficient capacity to carry away the heavy rainfalls hat occur from time to time, especially during hunderstorms, as rapidly as they fall, and there are number of unknown factors, such as the storage apacity of the sewers and drains and the fact that during a storm the flow in the sewers may be backards as well as forwards, which prevent precise alculations being made. Where it is necessary to onstruct basements with floors below the possible ood level in the sewers, there are advantages in not raining such basements; where such basement rainage is required in old or new buildings, the risk f flooding can be reduced to a minimum at no great xpense.

Freshwater Fish Farming

The Freshwater Biological Association of the British Empire has just published a pamphlet on the "Production of Freshwater Fish for Food" by Dr. T. T. Macan, Dr. C. H. Mortimer and Dr. E. B. Worthington (Freshwater Biological Association, Wray Castle, Ambleside, Westmorland, Sci. Pub. No. 6, pp. 36. Price to non-members 1*s*. 6*d*.) Fresh water covers about 340 square miles in England and Wales and about a similar area in Scotland. The total area is, therefore, comparatively small; but in war-time these inland waters should not be neglected since they can yield crops of food at the cost of little labour. The chief aim of the pamphlet is to make available some of the methods, especially those involving the use of manures, by which crops of fish from fresh water can be increased. The most suitable fish for stocking ponds are carp (*Cyprinus carpio*), tench (*Tinca tinca*) and rainbow trout (*Salmo irideus*). Other freshwater fish are considered, though most of them are unsuitable for rearing in ponds. Perch, for example, tend to become too numerous, and a method of perch trapping is described in the pamphlet (see also Nature, 148, 651; 1941). Improvements in eel fishing are also discussed. Other topics considered in the pamphlet are: the food chain in natural waters, productivity of natural waters, methods of increasing productivity, pond management and construction, stocking and cropping, lay-out of a carp farm, sewage fishponds. Anyone possessing a pond or concerned in any way with areas of fresh water of reasonable size should obtain a copy of this pamphlet.

Air-raid Damage and Electricity Supply

In its issues of March 13 and 20, the *Electrical Review* publishes the results of a works investigation by E. A. Beavis of cable breakdowns due to bomb damage and the resulting short-circuits, the implications of which, on a cable of comparatively small cross-section, seem to warrant careful consideration by power distribution engineers (see also Nature of February 7, p. 173, and March 28, p. 362). This cable, having an area of 0·023 sq. in., was insulated for 11 kv. and provided with a B.O.T. sheath and a lead sheath which was double steel-tape armoured and served. It had operated since 1926 on a 6·6 kv. system. During a severe raid, a bomb explosion damaged the cable at a point 708 yd. from the main sub-station and also a 0·10-sq. in., 3-core, 6·6 kv. cable running close by along the same route. The switch controlling the 0·023-sq. in. cable did not trip, although the 0·10-sq. in. cable was tripped out on short-circuit protection. Excavation disclosed damaged places in the 0·023-sq. in. cable at five points within a distance of about 150 yd. from the main sub-station. The faults were cut out and removed for examination. With the exception of No. 5—the farthest from the station—all the failures showed similar characteristics and in appearance were more like bursts or blow-outs than true electrical faults.

At fault No. 5 the cable had burst completely, one steel tape only holding the parts together. At the break, the conductor strands showed signs of fusing, while the lead sheath also had been partly melted; a short-circuit had evidently occurred at this particular spot. From the collected evidence, it seems that two distinct breakdowns occurred, the first of which was at the crater caused by the explosion and the second at fault No. 5. From a consideration of the circuit conditions prevailing it was concluded that from the very outset the 0·023-sq. in. cable was too small to be able to deal with the large fault kva. capacity available—approximately 260,000 kva. at the main sub-station. A factor contributing largely to the excessive damage occasioned was the comparatively long time-delay in the switch tripping arrangements; with a minimum relay setting of practically 0·9 sec. and a switch action taking 0·4 sec., the total clearance time was almost 1·3 sec. Had this operation been much quicker, say 0·4 sec. or less, the temperature would not have reached 200° C. and the deterioration in the cable would not have been excessive. The second part of the article gives a theoretical study of the factors involved in co-ordinating cable size with system characteristics from the point of view of the large fault kva. likely to be experienced.

Bio-Physics in the United States

The growing importance of bio-physics is recognized in a new feature of the *Review of Scientific Instruments*, published by the American Institute of Physics. Starting with the new volume, 13, the scope of the journal is enlarged to include physical instruments useful in biological research. In the issue dated January 1942, Detler W. Bronk discusses physical instruments for the biologist. Reference is made to the outstanding work of Helmholtz, Keith Lucas and A. V. Hill in the combined fields of physics and biology. Progress in the physical sciences is soon reflected in the advance of biology and medicine. As these sciences become more analytical, more revealing methods of observation, more precise instruments for measurement and more accurate means for the control of experimental conditions are needed. Investigators have extended their large-scale analyses down to the small scale of the activity of the cellular units of the organism and their molecular structure. This requires extraordinary sensitivity and high resolving power in the instruments. Furthermore, some of the phenomena occur with great rapidity.

One of the great faults of extreme specialization lies in the tendency to produce journals of similar extreme specialization, so that workers in the restricted field need 'waste' no time in reading outside their subject. As a result they are often ignorant of fields where their own specialized knowledge would be of the greatest help. The danger is very great in biophysics. Whereas every medical student must spend a part of his time studying physics, it is quite unusual for the physicist ever to have studied biology. Time-tables in universities often prevent a student including one of the biological sciences in a course involving both physics and mathematics. The new development, by which papers on biophysics will be included in a journal devoted to general physics, will prove unusually valuable in directing the attention of physicists to a new field containing problems of which many may be quite unaware. The first three papers in the new section deal respectively with an analyser for 1 c.c. of respiratory gas, with volumetric microrespirometers capable of an accuracy of the order of 1/100 mm.^{3} an hour and with an electrical capacitance diaphragm manometer for direct pressure measurements in the arterial blood stream. This latter instrument uses a radio-frequency, crystal-controlled oscillator and a pressure-sensitive condenser in the pick-up unit.

The Direct-Current Amplifier in Industry

In a paper read before the Institution of Electrical Engineers on March 6, D. C. Gall describes the design and behaviour of a direct-current amplifier, entirely alternating-current mains-operated, and having an accuracy independent of mains' fluctuations or change in valve characteristics. The voltage to be amplified is applied to a reflecting galvanometer in series with a resistance. The light from the galvanometer strikes a photo-cell which controls the grid voltage of a thyratron valve, this voltage shifting according to the illumination of the photo-cell. The grid voltage makes the thyratron conducting between its anode and filament circuit for part of the positive half-wave and, as the phase of the grid voltage advances, the conducting period lengthens, giving a larger effective rectifier current output. This current is fed back through the resistance so that the voltage drop opposes the applied voltage, the drop rising until the input voltage is balanced. Output current is thus proportional to input voltage. The thyratron anode current is supplied from a 250v.-section of the mains transformer and it operates the amplifier output circuit apparatus. Smoothing condensers and inductances convert the thyratron unidirectional current pulses into steady direct current and suppressing circuits eliminate radio interference from these pulses. The amplifier has an output of three watts and a power gain of about 10^{10}. It can be used as a voltage- or current-amplifier and is extremely stable. It has been applied to high-speed temperature-recording of liquid steel, to the metering of heat transport in large hot-water plants, to optical pyrometry, measurements of illumination by barrier-layer type photo-cells, to the polarograph and to many other problems in which very small E.M.F.'s are available as a function of the quantity to be measured. The departure from linearity of response is of the order of only a few parts in 10,000, and voltages of a few microvolts and currents as low as 0·01 microamp. can be amplified and thus used to operate recorders and controllers.

Uses of Laminated Densified Wood

An article by A. E. L. Jervis in the *Electrical Review* of March 27 describes the insulating properties and tooling applications of the so-called densified woods. In contrast to the mechanical shortcomings of solid wood, the laminated densified varieties are very strong and can be good electrical insulators, resisting corrosion and acid as well as moisture absorption, in which respect those produced under greatest pressure with the largest resin impregnation content appear to afford the best results. They can be substituted for metals, being more suitable (one sixth the weight of steel) in some cases, easier to machine and modify, and more quickly produced in a variety of thicknesses and shapes, so lending themselves to mass fabrication. Laminated densified woods can have tensile strengths up to 34,000 lb. per sq. in. and compressive strengths between 18,000 and 30,000 lb. per sq. in., depending upon veneer orientation with respect to the direction of the wood grain. Fanwise arrangement of the veneer laminations is suited to the manufacture of circular articles; 45° stacking is a simplification, and a 90° arrangement is the standard for material used for aircraft tool-making.

Two varieties are made by Moulded Component (Jablo), Ltd., both being produced hot under pressure

One grade, 'Jabroc', consists of alternate laminations of wood veneers and glue films and is used primarily for its mechanical superiority when electrical stressing is light. The dielectrically better 'Insul-Jabroc' consists of impregnated veneers only and is essentially an insulator for use indoors, out of doors, or under oil. Electric strength tests made on two 0·25-in. thick 'Insul-Jabroc' boards selected at random, each consisting of twenty-one veneers of beech wood, resulted in puncture at 65 kv. when impregnated with cresol resin, and at 62·5 kv. with phenol resin. Applications of densified wood are generally similar to those of the better-known moulded plastic substances; a typical electrical example is instrument panels aboard ships, while as a secondary dielectric it can be used for insulator spindles for overhead power lines. It also finds application in the fabrication of air screws and in the manufacture of tools for the aircraft industry, where its lightness can be an important factor in the increasing amount of female labour being employed in factories. In some cases in which girls have been unable to handle large steel jigs, for example, the introduction of laminated materials may effect up to 80 per cent saving in tool weights.

Cellulose Acetate Yarn for Wire Insulation

In an article by D. R. Brobst (*Bell Lab. Rec.*, 20, No. 5; 1942) it is pointed out that, about twenty years ago, a preliminary investigation was made on cellulose acetate yarn samples which indicated that its electrical properties are superior to those of silk. By 1925 the trend towards the use of acetate yarn in the textile industry was accompanied by the establishment of several plants in the United States to produce this yarn. Trial installations were made in several telephone offices, primarily to determine the handling characteristics of the material during manufacture and installation, and to obtain data on the service ageing properties. At first, mechanical difficulties experienced in handling the wire offset the price difference between the silk and acetate yarn so that no economic advantage could be obtained by its adoption. With further expansion in the use of acetate yarn in the textile industry and the resulting reduction in price, methods of handling were developed so that the yarn could be used in regular manufacturing processes without difficulty. The advantage to be gained from the use of acetate yarn from the point of view of electrical characteristics and price not only warranted substitution of this material for silk in silk and cotton insulated wires, but also amply justified the use of a wire with double wrappings of acetate yarn, a single wrapping of cotton and a lacquer coating, in place of wire which had been made with a double wrapping of cotton and cellulose acetate coating.

Card Index of X-ray Diffraction Data

A 4,000-card file index of X-ray diffraction data for use in the Hanawalt method of chemical analysis by X-ray diffraction has recently been published by the American Society for Testing Materials. This compilation is sponsored by a joint committee of the Society and the National Research Council, under the chairmanship of Prof. Wheeler P. Davey, Pennsylvania State College. The data include not only those obtained by Dr. J. D. Hanawalt and his associates and contributed by the Dow Chemical Co., with later corrections, but also additional data that have been contributed by the Aluminum Co. of America, the New Jersey Zinc Co., together with data taken from the technical literature in the English language. The cards give all pertinent data found in the sources, with provision for insertion of accessory data such as crystal structure, density, etc. The index identifies the strongest three lines in the X-ray diffraction pattern of some 1,300 crystalline compounds, the chemical names and symbols of which are as given by the various sources. The Hanawalt method has been described in the technical literature and a committee of the American Society for Testing Materials is perfecting a tentative recommended practice for the identification of crystalline materials by the X-ray diffraction method. Copies of the index, packed in finished container boxes, can be obtained from the American Society for Testing Materials, 260 S. Broad Street, at 50 dollars per set.

Leeches

Unlike the L.M.B.C. Memoirs, from which they admittedly received their inspiration, the Indian Zoological Memoirs are not confined to the description of marine organisms, and the most recent to be published under the able editorship of Prof. K. N. Bahl is No. 8 on Hirudinaria, the Indian cattle leech (Lucknow, 1941), by Dr. M. L. Bhatia. Those instructors in Great Britain faced with providing senior students with class material will read with envy that *H. granulosa*, the type chosen, is common in India and that fully grown specimens attain a length of 12–14 in. This monograph is a straightforward and readable account of Hirudinaria from a number of different points of view, and the frontispiece is a coloured plate of the entire animal. In the first chapter the classification is dealt with, and an adequate review of the systematics of the Hirudinea is provided in order to show the position and relationships of Hirudinaria to the other leeches. The family Hirudidæ, to which it belongs, and the genus Hirudinaria are naturally more fully dealt with than the remainder. The main part of the book contains a very good account of the anatomy and histology of the leech illustrated by clear drawings, but it is permissible to pick out two chapters as being exceptionally useful. These are the ones dealing with the cœlom and hæmocœl system and the excretory system, matters that receive inadequate treatment in most text-books. Altogether the monograph reaches a high level, and is particularly welcome since the information it contains, most of which applies with slight modification to Hirudo, is not readily available to the ordinary student. Author, editor and publisher alike deserve the congratulations and thanks of zoologists not only in India but in other countries as well.

Medical Advances in the Argentine

In a recent paper (*Bol. Ofic. San. Panamericana*, 20, 1265, 1941) Dr. B. A. Houssay, director of the Institute of Physiology in the University of Buenos Aires, surveys some of the more important contributions to medical science in the Argentine during the last few years. The work at the Institute of Physiology includes studies of the role of the anterior pituitary lobe in carbohydrate metabolism and diabetes, hypertension of renal origin, fluorosis, the role and regulation of plasma potassium, the normal and pathological physiology of urobilin and bilirubin, the sex hormones and the interaction of the glands of internal secretion. At the Institute of Nutrition directed by Prof. Escudero research work was done on milk, dietetics of childhood, national foods and vitamin C. At the Institute of Experimental Medicine directed by Prof. A. H. Roffo investigation was carried out on the carcinogenic action of tars (from coffee, tea, maté and tobacco), of derivatives of irradiated cholesterol, of diets based on cooked fats and of the production of cutaneous cancer in rats repeatedly subjected to the action of the sun and ultra-violet rays. The Bacteriological Institute of the National Department of Health directed by Prof. Sordelli not only prepares sera, vaccines and hormones, but also carries out research work on various infectious diseases such as brucellosis, bacillary dysentery, enteric fever, sylvatic plague, psittacosis, trypanosomiasis, uncinariasis, influenza and typhus. Important investigations have also been made on the adrenals and vitamin A at the Institutes of Physiology and Pharmacology of Rosario, and on endocrinology, electrocardiography and blood groups, at the Institute of Physiology at Córdoba.

Artificial Insemination of Cattle

ARTIFICIAL insemination of animals has been applied for some years in a number of countries. Advantages claimed for the practice are the lessening of the risk of spread of disease in livestock, reduction in sterility and increase in fertility, facilitation of improvement in quality, and economy in livestock management. Trials of artificial insemination of cows on a practical scale have been recommended by the Agricultural Improvement Council for England and Wales to be carried out in the first place at two centres, Cambridge and Reading, by the Cambridge School of Agriculture and the National Institute for Research in Dairying respectively, under the guidance of a supervisory committee and with the assistance of local committees for the two areas. The supervisory committee is as follows: Prof. J. Scott Watson (chairman), Prof. J. F. Craig, Mr. J. H. Everall, Dr. John Hammond, Mr. Robert Hobbs, Mr. P. A. Mytton, Mr. C. Nevile, Capt. J. Templeton.

Horticultural Composts

WORK upon the scientific mixing of composts performed at the John Innes Horticultural Institution has been condensed into a useful short paper by W. J. C. Lawrence (*J. Roy. Hort. Soc.*, 67, Pt. 3; March 1942). The new composts involve the use of sterile peat and very coarse sand for the improvement of texture, partial sterilization of turf loam by steam to eliminate harmful organisms and substances, and the addition of "John Innes base", a mixture of fertilizers. This base consists of a slowly available nitrogenous manure, a preponderance of superphosphate, and a little sulphate of potash. Details for the mixing of seed and potting composts are given in the paper, and fuller details are available in a leaflet (from the Institution, 31 Mostyn Road, London, S.W.19, price 6*d.*).

Two Early Plant Collectors

A SHORT paper by the Right Rev. J. W. Hunkin, Bishop of Truro (*J. Roy. Hort. Soc.*, 67, Pt. 2; Feb., 1942) describes the work of William and Thomas Lobb, two of the first plant collectors employed by James Veitch and Sons about 1840. William was responsible for such familiar introductions as *Berberis Darwinii* and *Escallonia macrantha* from Chile, while Thomas brought many new rhododendrons and orchids from Malaya.

Royal Society of Edinburgh Year Book

IN 1940 it was decided that the *Proceedings of the Royal Society of Edinburgh* should be published in two sections, "A" (Mathematical and Physical) and "B" (Biological), and the appendixes and certain other matter issued separately. The first issue of this additional material has now appeared under the title of "Year Book of the Royal Society of Edinburgh, 1940–1941" (price 5*s.*). It includes obituary notices, brief 'proceedings' of the meetings held during the session, lists of recent awards of the Society's medals, etc., membership list, and the laws of the Society. It will be very convenient to have these details of the constitution and activities of the Society in separate and handy form for reference purposes.

Announcements

DR. CHARLES OLMSTED, of the Department of Botany of the University of Chicago, has been appointed botanical editor of *Ecology*. He succeeds Prof. Francis Ramaley, of the University of Colorado. Prof. Thomas Park, of the Hull Zoological Laboratory of the University of Chicago, remains editor for zoology.

PROF. ADOLF WINDAUS, professor of chemistry in the University of Göttingen, well known for his researches on vitamins, has been awarded the Goethe Medal for Art and Science on the occasion of his sixty-fifth birthday.

THE following appointments and promotions have recently been made in the Colonial Service: W. S. Luke, to be veterinary officer, Kenya; R. Johns, agricultural officer, Fiji, to be director of agriculture, Leeward Islands; C. W. Elliot, assistant conservator of forests, to be senior assistant conservator of forests, Kenya.

THE following awards have been made by the American Institute of Electrical Engineers: Edison Medal to Dr. J. B. Whitehead, professor of electrical engineering at the Johns Hopkins University; Alfred Nobel Prize for 1940–41 to Robert F. Hays, jun., of the research laboratories of the Sperry Gyroscope Company, for his paper entitled "Development of the Glow Switch".

THE immediate establishment of a Scientific Advisory Council for the war effort has been officially announced in Jerusalem. The Council will work in close co-operation with the Palestine Government. Dr. Judah L. Magnes, president of the Hebrew University, has been appointed president, and Prof. Farkas secretary of the Council, the membership of which will consist of representatives of the Hebrew University, the Technical High School at Haifa, and the Agricultural and Daniel Sieff Institutes at Rehovot.

ERRATUM. In NATURE of April 4, p. 383, "Linkage of Physico-Chemical Processes in Biological Systems' by Prof. E. J. Conway, equation 4 should read

$$2\ {}_K = C_Y + \sqrt{C^2{}_Y + 4\,(C'_K{}^2 + C'_K C'_N)}.$$

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Behaviour of Lipoids in Human Serum

Filtered human serum gradually becomes turbid through the formation of a precipitate which is mainly lipoid. The presence of approximately 7 gm. of lipoid in 1 litre of human serum is shown by shaking with a mixture of ether and alcohol[1], when the protein is precipitated and the lipoid goes into solution. When ether alone is used, the protein is not precipitated, and negligible amounts of lipoid are contained in the ether extract. It has not hitherto been believed possible to remove lipoids in any quantity from serum by the use of ether alone.

If serum is shaken with ether and the mixture frozen below −25° C., on subsequent thawing a coloured ether layer forms on the surface containing large amounts of lipoid. Freezing at temperatures above −20° C. fails to produce lipoids in the ether layer, and freezing at temperatures down to −70° C. does not increase the amount in the extract. There is no apparent advantage in freezing for longer than is required to bring the bulk of frozen material uniformly to below −25° C. From 1 litre of human serum shaken with 300 ml. ether and frozen to −25° C., 3·5 gm. lipoid is obtained in the extract which forms on the surface after thawing in cold water and allowing to stand at room temperature for 6–8 hours. The underlying serum is siphoned off and will give another 0·85 gm. lipoid if shaken with 100 ml. ether and frozen. On repeating this, another 0·2 gm. lipoid is obtained, each successive extract containing approximately one quarter the lipoid of its predecessor.

A litre of serum which has been exhaustively extracted in this way gives a further 2·5 gm. lipoid on treatment with ether-alcohol. The serum separated at each stage is not clear to transmitted light but may be clarified by centrifuging. The final product contains 11 per cent dissolved ether, which can be removed in various ways. Freezing once more and thawing after removal of the ether causes the deposition of a gelatinous material of low solubility in cold water, and if this is removed by filtration in the cold through an ordinary filter paper the siphoned as well as the centrifuged product is perfectly clear at all temperatures and filters readily through a bacteria-retaining filter.

Electrophoresis photographs of human serum before and after the extraction show only one difference, namely, that the concentration of β-globulin has been reduced by the extraction. It follows that much of the apparent β-globulin of human serum is a lipoid-β-globulin complex so orientated that the protein determines the surface properties of the complex; or alternatively, that β-globulin itself is a compound of lipoid and a serum protein having surface properties different from those of its constituents. It is not possible to decide between these views on the evidence available, but it is at least clear that in the β-globulin fraction of human serum much lipoid is associated with a hydrophylic substance in such a way that it behaves atypically, that is, as a water-soluble and ether-insoluble material.

In the region of the eutectic temperature (−23° C.) of sodium chloride, serum becomes truly solid and, after thawing, the previously clear serum is cloudy. Similarly, serum which has been dried from the frozen state but not from the liquid state is reconstituted with water to form a milky suspension. This suggests that the association of lipoid with a stabilizing substance depends on the presence of liquid water and is destroyed by freezing. On subsequent thawing, unprotected lipoid is able to aggregate to visible particles or droplets. These, however, soon re-acquire the same stabilizer from solution, because the initial rate of aggregation is not maintained and the formed particles can be observed with the naked eye to migrate with the β-globulin boundary. The lipoid of these particles is also not extractable with ether unless accompanied by freezing.

After freezing and thawing, it must be assumed that a lipoid phase has been created in equilibrium with the aqueous phase, and if dissolved ether is present in the serum it will redistribute itself between the two. Lipoid aggregates containing dissolved ether rise to the surface and merge with the excess of ether there to form a solution of lipoid in ether. It may be suggested as an alternative to this that ether droplets containing dissolved lipoid are formed between the ice crystals on freezing, and owing to the low miscibility of ether in water these are able to rise to the surface carrying lipoid with them without re-solution of the ether taking place. This is contra-indicated by the observations that an extracted serum saturated with ether does not form an ether layer after freezing and thawing, and an unextracted serum saturated with ether but having no excess of it on the surface has the appearance after freezing and thawing of an emulsion and on standing a fatty layer collects at the surface.

The method of extraction has been used to clarify blood-grouping sera which had become cloudy, and these showed little or no reduction in agglutinin titre and remained clear in ether for nearly a year. Extracted human serum after drying from the frozen state is reconstituted with water to form a clear solution, and there is no evidence that the physical properties of the serum proteins have been affected by either process. For reasons not understood, most of the excess fat in a lipæmic serum is extractable with ether without freezing and the same has been found for the serum of nephrotics[2]. Details of the application of the method to citrate plasma are being published elsewhere.

Arthur S. McFarlane.

Lister Institute,
London, S.W.1.
March 31.

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[1] Hardy, W. B., and Gardiner, Mrs. S., *J. Physiol.*, **40**, 68 (1910).

[2] Longsworth, L. G., and MacInnes, D. A., *J. Exper. Med.*, **71**, 77 (1940).

Metabolic Products of 3 : 4-Benzpyrene

In 1936, Peacock[1] observed that animals receiving intravenous injections of 3 : 4-benzpyrene excreted in the bile an alkali-soluble product (*BPX*) possessing specific fluorescence bands which differed from those of the parent hydrocarbon. Subsequent investigations by Chalmers[2,3] demonstrated the existence of a similar phenolic derivative in the fæces, and this led to its isolation and purification. From recent crystallographic analysis[4], this metabolic product is considered to be a monohydroxy-benzpyrene.

In a study of the oxidation of benzpyrene by ascorbic acid *in vitro*, Warren[5] has found, in addition to the two known quinones (5 : 8- and 5 : 10-), a phenolic substance, soluble in alkali, giving a strong green fluorescence. In view of the apparent similarity of this synthetic phenol to the metabolic phenol *BPX*, and since *in vitro* the formation of the quinone preceded that of the phenol, Warren suggested that *BPX* might be a partially reduced quinone.

Previous work on the isolation of metabolic derivatives of benzpyrene has been hampered by the small yields of the products, due partly to their instability and partly to the small amounts produced. The latter was due, in the case of intravenous injection of benzpyrene, to the small amounts which can be injected by that route, and in the case of subcutaneous injection, to the slow rate of metabolic change under those conditions. From a study of the fate of benzpyrene in the animal body under different biological conditions[6], it was found, however, that the body metabolizes benzpyrene about fifteen times more rapidly when injected intraperitoneally than when injected subcutaneously. By taking advantage of this difference, it became possible to investigate the nature of the metabolic products of benzpyrene on a more extensive scale.

The fæces of rats which had previously been injected intraperitoneally with large amounts of benzpyrene were desiccated, ground to a fine powder, and continuously extracted with cold benzene. On purification of the extract by chromatography, etc., it was possible to isolate, in addition to the phenolic product *BPX*, a red crystalline substance, possessing similar properties to the synthetic red quinone (5 : 8-) obtained by the method of Vollmann *et al.*[7]. On reductive acetylation or methylation, strongly fluorescent compounds with distinctive spectra were obtained, those derived from the synthetic quinone being similar in type to those derived from the metabolic quinone. They both appeared to be very different, however, from the acetyl and methyl derivatives obtained directly from *BPX*. This is in keeping with the conclusion reached by Chalmers and Crowfoot[4] that *BPX* is a monohydroxybenzpyrene, since, on acetylation or methylation, such a substance would be expected to yield the corresponding mono-derivatives, in contrast to the di-derivatives which may be expected from the quinones.

On the other hand, on standing in air (and, more rapidly, by treatment with oxidizing agents), *BPX* tends to change partially into the red quinone, a reaction which rather suggests that it is a dihydroxybenzpyrene.

While further investigations are still in progress, the results so far available are not incompatible with the view that both a mono- and a di-hydroxybenzpyrene are produced in the body, the former being slowly converted into the latter, and the latter being rapidly converted into a quinone.

I. BERENBLUM.
R. SCHOENTAL.

Oxford University Research Centre
of the British Empire Cancer Campaign,
Sir William Dunn School of Pathology,
University of Oxford.
March 21.

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[1] Peacock, P. R., *Brit. J. Exp. Path.*, **17**, 164 (1936).
[2] Chalmers, J. G., *Biochem. J.*, **32**, 271 (1938).
[3] Chalmers, J. G., *Biochem. J.*, **34**, 678 (1940).
[4] Chalmers, J. G., and Crowfoot, D., *Biochem. J.*, **35**, 1270 (1941).
[5] Warren, F. L., *Proc. Biochem. Soc., Chem. and Ind.* (in the press, 1942).
[6] Berenblum, I., and Schoental, R., *Biochem. J.* (in the press, 1942).
[7] Vollmann, H., Becker, H., Corell, M., and Streeck, H., *Ann. Chem.* **531**, 1 (1937).

Effect of Chorionic Gonadotropin on the Pouch of the Marsupial *Trichosurus vulpecula*

THE pouch of the sexually mature, non-pregnant common Australian phalanger or possum (*Trichosurus vulpecula*) shows a marked reaction towards the administration of gonadotropic hormone obtained from human pregnancy urine. The immediate response during the period of administration is a decrease in the size of the pouch, but after about three injections of 200–500 I.U., the pouch expands *markedly within a few days after the final injection.* The increase in size in the caudal direction extends down to the pubis; in the lateral direction the cavity may expand over the whole of the lower abdominal wall. In such cases the extended pouch would be capable of housing a large pouch young of about one eighth of the body-weight of the mother. With the expansion of the pouch, mammary glands and nipples also increase in size and the interior of the pouch becomes very moist due to the secretion of a fluid which at first is colourless and then turns brown. This enlarged pouch persists for about a week, then slow involution takes place extending over several weeks.

In comparing the action of œstrogens[1] and progesterone[2] with that of gonadotropin, it may be pointed out that œstrogens bring on a contraction, and progesterone, after a slight preliminary expansion, a relaxation and eversion, while gonadotropin brings *on an enlargement of the pouch. It therefore appears* that the same hormones may control the activities of the pouch and of the eutherian uterus.

A. BOLLIGER.

Gordon Craig Research Laboratory,
Department of Surgery,
University of Sydney.
Feb. 3.

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[1] Bolliger, A., and Carrodus, A., *J. Roy. Soc. N.S.W.*, **73**, 218 (1940).
[2] Bolliger, A., and Carrodus, A., *J. Roy. Soc. N.S.W.*, **73**, 228 (1940).

Heterothallism and Reproduction in Fungi

WE are grateful for the clear genetical interpretation of heterothallism given by Dr. K. Mather[1], and may perhaps be allowed to carry his conclusions regarding reproduction in fungi a step further. We have been thinking on these lines for some time, and in a joint discussion held by Sections D and K at a meeting of the British Association in 1937, the suggestion put forward by one of us[2], that the heterothallism of some fungi might be compared with the incompatibility of some angiosperms, was not received sympathetically by the mycologists.

The evolution of heterothallism in fungi, a phenomenon not necessarily the outcome of sex, but possibly an independent and alternative process, has brought with it the problem of the bringing together of opposite strains: a problem intensified by the non-motile 'gamete' of the *majority of fungi, and o*[illegible] peculiar importance in parasitic forms. Various mechanisms have been evolved which achieve this end, and it is in the interpretation and naming of these mechanisms that confusion has arisen between heterothallism and sex. The process whereby the strains are brought together has been spoken of as the actual sexual process, whereas in many instances it no more represents a sexual process than does the carrying of a pollen grain to the stigma of an angiosperm. In many forms the strains are brought together by the dispersal of asexual spores such as oidia and papulospores which multiply the individuals of one or other strain and serve to disperse them so that intermingling will be more assured. When the appropriate strains meet, one of two things may happen: (*a*) sexual organs are formed as soon as contact is established (Mucor, Dictyuchus) or (*b*) mycelial fusions occur in vegetative hyphæ mingling the protoplasm and associating the nuclei of the two strains, which fusions may be between two hyphæ, or two spores, or hypha and spore. A further development of this last type of fusion might give rise to a hypha specialized to catch the spore. Such a mechanism does not convert the spore into a gamete or make it necessary to assume that in *Pleurage anserina*[3,4], for example, we have a trichogyne catching a spermatium, particularly as in *Neurospora tetrasperma*[5] the trichogyne may fuse with ordinary vegetative hyphæ.

The analogy of the transference of pollen in seed plants and the transference of oidia in the higher fungi becomes very close when the 'devices' of colour, scent, and nectar are found in the pycnidium of rusts as well as in the flower, and when insects are found to serve as the agents of transference in both.

These vegetative fusions give rise to the peculiar condition found in numerous Basidiomycetes and Ascomycetes, where two different kinds of nucleus are found within a thallus, and nuclear fusion is delayed. Here there is no need of sexual organs and it is possible to argue either that sexual organs have been lost or that sexual organs have never arisen in this line of evolution. The plant secures nuclear association without them. The recognition in some Ascomycetes of an oogonium without antheridium can be used as evidence in support of the former view. On this argument antheridia have disappeared first and the oogonium has been retained either (*a*) as a sorting-out place of the pairs of nuclei or (*b*) as a place of fusion. The assumption that this 'oogonium' is a normally functioning sexual organ may explain the theories of double fusion and brachymeiosis in Ascomycetes—a phenomenon universally unacceptable to geneticists. The evolution of the clamp connexion renders unnecessary the presence of an oogonium even as a sorting-out place for the nuclei, and it is significant that in forms with conjugate division of dicaryons (even though there be no clamp connexions) there appear to be no sexual organs. They may have been lost but possibly they never existed.

MARGARET A. P. MADGE.
ELIZABETH BLACKWELL.

Royal Holloway College,
(University of London),
Englefield Green,
Surrey.
March 24.

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[1] Mather, D. K., NATURE, 149, 54 (1942).

[2] Madge, M. A. P., B.A. Report Nottingham, 423 (1937).

[3] Ames, L. M., *Mycologia*, 26, 392 (1934).

[4] Dodge, B. O., *Mycologia*, 28, 284 (1936).

[5] Dodge, B. O., *Mycologia*, 27, 418 (1935).

External Genitalia of the Diptera

IN medical and veterinary entomology specific and generic determination of flies is dependent upon the structure of the genital apparatus. There is no recognized standard for naming the modified terminal segments and appendages (terminalia) of the abdomen in the Cyclorrhapha. Morphologists have found no conclusive evidence to settle the nature of, nor have taxonomists managed to agree upon the naming of, these sclerites and other parts concerned. Nevertheless there are four papers that have, between them, covered the groundwork required to solve this problem. Together they make an entirely new approach and I have co-ordinated the data. The following conclusions that are drawn from this study are surprising, but logical.

(1) The normal Nematocera have ten observed abdominal segments, the tenth being the proctiger, which includes the anal papilla. The ninth segment incorporated the ædeagus, and these two together form the hypopygium. The ten abdominal segments lie in a rectilinear series with the anal papilla, lying in a plane above that of the ædeagus which points posteriorly, that is, away from the head of the fly.

(2) The first change to take place is in the hypopygium, which rotates on its longitudinal axis through 180°, becoming inverted as in mosquitoes. Here the ædeagus lies in a plane above that of the anal papilla, and retains its character of pointing posteriorly.

(3) The terminal segments of the abdomen, usually from the sixth onwards, change their line of direction to a curvilinear series, so that the hypopygium is turned to point laterally, dorsally and ventrally, and hence the ædeagus no longer points posteriorly, numerous examples of which are found in the Empididæ and Dolichopodidæ.

For the purpose of the present discussion, it is necessary only to consider the case where the abdomen curves through a half circle in a lateral direction, so as to have the ædeagus pointing anteriorly, that is, towards the head of the fly as in Syrphidæ.

(4) In the Orthorrhapha, every fly that has the anteriorly directed ædeagus always has a simple curvilinear form of the abdomen, so far as known. The hypopygium here is never inverted, so the eighth and ninth tergites are adjacent one to the other.

In the Cyclorrhapha, on the contrary, the hypopygium is invariably inverted, the ninth tergite always being adjacent to the eighth sternite. Metcalf has given the evidence for Syrphidæ very clearly, but he marks the eighth sternite as being the ninth urite, having had doubts about its nature.

The course of the spiracles and the loop of the genital tract over the alimentary canal are found to be common to all the Cyclorrhapha, showing that fundamentally the terminalia of the Syrphoidea and those of the Muscoidea are based upon common ground.

(5) By following this evidence logically, it can be seen that the apical segments of the Muscoidea must have their eighth and ninth sternites on the dorsal surface, comparable to that already shown for Syrphoidea by Metcalf. The ædeagus moves forwards to lie under the eighth sternite in both cases. The so-called 'cerci', that is, the styles of Metcalf, are derived from lobes of the ninth tergite which is, itself, retained in vestige by the Syrphoidea, but is obsolete in Muscoidea. Similar lobes are derived

from the eighth sternite and sometimes from the seventh sternite too, the *Calliphora sternalis*-group being an example.

This sequence of changes that takes place in the terminalia was seen when studying the four following papers :

(*a*) C. L. Metcalf, *Ann. Ent. Soc. America*, 14, 169–214 (1921), who discusses "the genitalia of male Syrphidæ ; their morphology, with special reference to their taxonomic significance". Metcalf adds an extra segment to the base of the abdomen and produces a numbering of segmentation that is not followed by other authors. Reduction of his numerals by one brings the numbering to that of the above notes.

(*b*) G. C. Lamb, *Proc. Roy. Soc. London*, B, 94, 1–11 (1922), who uses the order in his account of "the geometry of insect pairing". Lamb overlooked the fact that the ædeagus is inverted on Syrphidæ, so his ideas on the terminalia are in need of adjustment. The correlation between the ædeagus and vagina is not direct but inverse, as Richards found.

(*c*) H. J. Feuerborn, *Zool. Anz.*, 189 (1922), who discusses "das Hypopygium inversum und circumversum". Feuerborn has overlooked the fact that the "circumversum" form of hypopygium can equally be gained by combining his "inversum" form with the curvilinear form of terminalia described by Metcalf and by Lamb. The hypopygium does not turn through 360° relative to the eighth segment as Feuerborn states, but is derived directly from the Syrphid type as Lamb suggests.

(*d*) O. W. Richards, *Biol. Rev.*, 2, 322–328 (1927), who discusses "the mechanical relations of the male and female genitalia" when reviewing "sexual selection and allied problems in insects". Richards reaches several conclusions that cannot be retained. The twist of the hypopygium is restricted to one way only throughout the Brachycera, namely from left to right, and the curvilinear development in Cyclorrhapha takes the same direction. Three segments each take 60° twists, not two at 90° each which Richards suggests.

The treatment of the so-called 'cerci' of authors, as reviewed in the above notes, is in alinement with my manuscript "The Copulation and the Terminal Segments of Diptera" ; typescript copies (about 10 pages and 25 text figures) will be made available to authors interested, on application being made to me personally, for with present printing restrictions it is not likely that the paper will be printed for many years.

G. H. HARDY.

University of Queensland.
Jan. 18.

Colour Measurement

MR. J. W. PERRY[1] quotes previous statements by me in contradiction of the view expressed by T. Smith, R. Donaldson and myself[2] that the C.I.E. standard-observer tables are not restricted in their application to a specified field size or other observing conditions.

The apparent contradiction arises from failure to appreciate the essential difference between measurement of the quantities occurring in the psychophysical relations which determine an observer's personal experience of colour and brightness matching, and measurement of quantities of the kind defined by the C.I.E. tables. It is to the former class of measurements that the statements in question apply ; measurement in terms of a public standard, conventionally accepted for technical purposes, was not within the scope of the paper quoted by Perry.

Adequate discussion of the points at issue within the limits of a letter is impracticable, and inadequate discussion would only leave room for further controversy. I propose, therefore, to prepare a statement for submission to the Physical Society Colour Group, where a full discussion may be possible.

Meanwhile it is sufficient to say that there is nothing in Mr. Perry's letter which appears to us to warrant modification of the views which we have expressed in these columns.

J. GUILD.

National Physical Laboratory,
Teddington, Middlesex.
April 7.

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[1] NATURE, **149**, 247 (1942).
[2] NATURE, **149**, 76 (1942).

First Publication of the Geological Society

IT is interesting to learn[1] that an original copy of the "Geological Inquiries", said to be the first publication of the Geological Society, has been discovered in the library of the Sedgwick Museum. When Woodward stated that "No records appear to have been preserved of the printed geological inquiries that were circulated among the members", he was evidently unaware that this pamphlet had been reprinted, apparently verbatim, in A. Tilloch's *Philosophical Magazine*, 49, 421–429 (1817). The queries were also included in full (unnumbered, and without the introduction) by Thomas Walford, F.A.S., F.L.S., in his "The Scientific Tourist through England, Wales and Scotland", London, 1818, 2 vols., 12mo. (vol. 1, pp. 50–55), a copy of which is in the library of the Geological Society. It may perhaps be of interest to add that the latter publication also includes a folding plate, "Geological Table of British Organised Fossils . . . with reference to Mr. Smith's Geological Maps". This is almost identical with Smith's well-known table which appeared in the later issues of the memoir accompanying his map and was also published separately.

One would like to know if the pamphlet is dated, or bears any evidence to show that it was actually published in 1808, or before 1811 (the year in which the first volume of *Transactions of the Geological Society* appeared). It seems strange that it should be included in a monthly scientific journal, without comment, nine years after it had been circulated to the fellows of the Society. It would be most interesting if Dr. Hawkes could provide evidence, either from the pamphlet itself or from the early minute books of the Society, to confirm the date of publication.

JOAN M. EYLES.

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Edinburgh, 9.

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[1] NATURE, **149**, 377 (1942).

NEW ZEALAND EARTHQUAKES DURING 1940

An interesting and informative account of New Zealand earthquakes and seismology during 1940 is given in Bull. No. R–26, of the Dominion Observatory, Wellington, published in the annual report of the Department of Scientific and Industrial Research, 1940–41 (New Zealand).

Data for the study of earthquakes are obtained locally in New Zealand from instrumental records of three main types and from personal experiences as follows: (1) from teleseismic instruments of varying sensitivity installed at Arapuni, Wellington, Christchurch and Chatham Islands; (2) from local strong-motion recorders, mostly Jagger seismographs, installed at Rotorua, Hastings, Bunnythorpe, Takaka, Greymouth and Monowai; (3) from sensitive local recorders of Wood-Anderson design situated at Tuai, New Plymouth, Wellington and Christchurch; (4) from reports of felt earthquakes from non-instrumental reporting stations established with the co-operation of the Post and Telegraph Department.

Periodical reports of felt earthquakes are also received from Dr. C. E. Fox in the Solomon Islands, and also from the Kermedecs. During 1940, 90 earthquakes were reported felt in the North Island, 40 in the South Island, 10 in both islands and 120 over the whole of New Zealand. In the North Island, maximum numbers were in March, July and August, in South Island in February, and in the whole of New Zealand in July.

The ten most important earthquakes occurred: (1) January 12 at 00h. 05·4m. N.Z.M.T., with maximum intensity 5 on the Rossi-Forel scale, felt extensively from Hawera to Akaroa, with maximum at Wanganui and Blenheim; (2) February 26 at 17h. 46·6m. with intensity between 6 and 7, felt throughout Hawke's Bay, with maximum at Hastings; also felt at Taihape and Wanganui; (3) March 20 at 02h. 23·5m. with intensity 7, felt in most eastern districts of North Island as far south as Dannevirke, with maximum in North Hawke's Bay; also felt in parts of Wanganui and Manawatu districts; (4) April 19 at 18h. 11·5m. with intensity 6, felt widely in North Island south of Napier, Taihape and Hawera, with maximum at Dannevirke (possibly two shocks); (5) July 10 at 05h. 28·1m. with intensity 6, felt at Whakatane; (6) July 23 at 01h. 01·5m. with intensity 4, felt in western areas of North Island from New Plymouth to Wellington, and at isolated points in northern part of South Island; (7) August 2 at 04h. 28·8m. with intensity 6, felt in Gisborne region and parts of northern Hawke's Bay; (8) August 2 at 04h. 37·4m. with intensity 6, felt in Gisborne and parts of northern Hawke's Bay; (9) October 7 at 12h. 55·65m. with intensity between 6 and 7, felt widely in North Island, except Auckland Peninsula; also at isolated places in South Island to Banks Peninsula; maximum in region between Opotiki and Hawke's Bay; (10) October 22 at 06h. 16·9m. with intensity 6, felt about Cook Strait.

From all the available information it will be seen, that the main features of the activity may be summarized as: (1) Two strong shocks centred in the Gisborne coastal regions on August 2. (2) Fairly continuous activity beneath the volcanic zone extending from near White Island to the region south-west of Lake Taupo from March onwards, with a particularly strong shock on October 7. This shock had a focal depth of 160–170 km. and was widely felt. Shocks at intervals centred in the Taumarunui region are considered to be part of the activity connected with the volcanic zone. (3) Activity in Hawke's Bay region reached a climax with the shock on March 20. It was followed by a swarm of minor aftershocks recorded at Tuai, most of which were too weak to be felt. Following this disturbance there was a steady decline in the intensity and frequency of the shocks, and between August and the end of the year only one shock was definitely located in Hawke's Bay. (4) Occasional minor activity centred in north-eastern Taranaki, probably associated with the shocks in the Taumarunui region. (5) Fairly frequent slight or moderate shocks in the Wanganui-Rangitikei region, many of which were centred in the Wanganui Bight. (6) Rather frequent shocks in the Wairarapa, Wellington, Marlborough and West Nelson regions during the latter half of the year, none of which exceeded Rossi-Forel 5. The coincidence of renewed activity in all these regions about June points to some common cause affecting shock activity in the whole area. (7) Activity in the submarine region east and north-east of the North Island in July–August, and again from October to December.

During 1940, tests were carried out near Greymouth and at Monowai with Milne-Shaw and Wood-Anderson seismographs. Both places were found unsuitable for the Milne-Shaw but suitable for the Wood-Anderson. The co-operation of the Public Works Department has been sought with the view of establishing a Wood-Anderson near Greymouth. Tilt recording has been carried on continuously at Wellington with the aid of the Ishimoto tiltometer and the Milne-Shaw seismograph. The Lands and Survey Department has furnished information on levels taken across geological faults at various points in the Wellington District during the period 1930–40. A study of these level readings, together with seismic data, indicates that certain level changes may have been associated with definite seismic disturbances, though more frequent level readings will be required to confirm this. Since 1936, systematic observations of the north and south meridian marks have been made with the transit instrument. Relative horizontal movements of any one of these points would be revealed by the observations. No appreciable displacements have so far been detected.

CHEMICAL ASPECTS OF TUBERCULOSIS

Dr. Florence B. Seibert, associate professor of physiological chemistry at the Henry Phipps Institute, Philadelphia, read a paper during the fiftieth anniversary celebrations at the University of Chicago in September last describing the results of recent chemical studies of the bacillus of tuberculosis.

Dr. Seibert stated that it is now possible to separate the polysaccharides and nucleic acid from the protein of the bacillus, and this has led to the discovery that there are several types of proteins derived from the tubercle bacillus, varying in potency. She also posed the new problem of whether the 'fast component', one of the tuberculin protein types, may be related to an unidentified 'extra' component in the blood serum of persons sensitized to tuberculosis.

This 'extra' substance, with a mobility slightly greater than that of the albumin normally present in the blood serum, is found to have exactly the same rate of mobility as the 'fast component' of the tuberculin protein.

There is no longer any doubt, Dr. Seibert said, but that the protein fraction is of paramount importance in many reactions accompanying the disease. The whole question of hypersensitivity and allergy is interlinked with sensitization to the protein. For this reason much effort has been spent in attempts to isolate the protein in pure form. This work has been carried on for many years, first at the University of Chicago and during the past nine years at the Henry Phipps Institute, with grants from the Medical Research Committee of the National Tuberculosis Association.

Each succeeding stage in the purification, however, has brought with it the realization of its great complexity. Through the use of some of the modern physico-chemical methods, especially the ultracentrifuge and the Tiselius electrophoresis apparatus, it has been possible to formulate a definite picture of the complex composition of the tuberculin protein and to obtain some leads for further purification.

The free polysaccharide and nucleic acid have been shown not to be responsible for the biological reactions so characteristic of tuberculin. However, they form very definite combinations with the protein, some of which dissociate only at certain hydrogen ion concentrations. For example, it was shown in a heated fraction that nucleic acid and protein travelled in electrophoresis as a single component at hydrogen ion concentrations more acid than *p*H 5·0, whereas on the alkaline side they existed as two separate components with very different mobilities. This protein can exist in various molecular sizes and shapes. In general, larger, less denatured, and more spherical protein molecules in the bacillus are more dangerous than smaller, more denatured, and more elongated molecules. Among the effects produced are the stimulation of the body to produce antibodies and the heightening of susceptibility to later exposures to the disease.

The tuberculin protein has a doubly dangerous effect because when introduced into a body never previously infected, it proves more poisonous than most ordinary proteins, and in addition, infection causes a heightened sensitivity to this protein when it is formed in the disease in later exposures, rather than immunity. For example, 100–150 mgm., given intraperitoneally, will kill a normal guinea-pig. Ten times this amount of a protein from another acid-fast bacillus, the timothy grass bacillus, was not lethal. The toxicity of the tuberculin protein is increased about a hundredfold in the tuberculous animal, the sensitivity of which has been greatly enhanced by the infection. There seems to be no evidence that the antibody which can be demonstrated in the blood stream is directly associated with immunity. In fact, animals highly sensitized to the protein did not possess an immunity to infection. They showed a lessened immunity.

Furthermore, there is no evidence for a bactericidal effect by the blood serums of highly immunized animals on the tubercle bacillus *in vitro*. On the other hand, there is evidence from the work of Dr. Max B. Lurie (also of the Phipps Institute) that the body fluids of tuberculous animals are bacteriostatic in experiments with living animals.

Analysis and sorting out of the molecule comprising the tubercle bacillus is made extremely difficult by the presence, and even association, of the polysaccharide and nucleic acid with the protein. However, with the development of a satisfactory method for removing these two impurities without harming the protein, a very active protein can now be isolated. The potency can be carefully standardized, and a quantity of such a preparation for general standardization purposes has been prepared. But it is still obvious that more research must be done in order to be able to separate the different kinds of protein molecules from each other and then to develop satisfactory methods for producing them at will and in desired quantities.

PALÆOLITHS FROM THE WORTHING ARCHÆOLOGICAL AREA

By F. W. H. Migeod

PALÆOLITHIC implements of early types have been found recently by two local residents in the Worthing archæological area. One collection was made on the Worthing shore by Mr. Barclay Wills. His work came to an end when access to the beach was prohibited in the early days of the War. Mr. R. K. Stevens was able to begin his at Angmering-on-Sea, about five miles to the westward, when grassland was ploughed up for cultivation. Most of his finds were on the surface, a few only, but they of large size, coming from ditches. I had practically completed a detailed description of Mr. Stevens's finds before Mr. Wills's came to my notice. As a result the joint collection here briefly reviewed consists of a hundred of Mr. Stevens's flints and thirty-three of Mr. Wills's.

The cultures were mainly similar. A glance at them shows the great variety of uses to which the flints were adapted. The flaking is bold, and minor chipping in general rare. Their time-range is wide. Some seem to be of eolithic type. The majority, however, may be classed as Chellean. Three may be Clactonian, one Acheulean and one Mousterian. There are also some intrusions, which is only to be expected from the proximity of the neolithic flint mining industry on the nearby downs. Although there are time distinctions, the absence of a clear stratification at Angmering-on-Sea renders precision in this respect out of the question.

The technique of the main body of implements from both sites is in the first instance cleaving a piece off the flint block with a single blow, thus producing a smooth lower surface. The outer and crustal surface is then flaked as required. The smooth under-surface is retained whatever may be the nature of the resulting implement. What sort of implement will emerge depends on how the maker views the possibilities of the fragment he proposes to work on. This factor disappeared when in the later stone age the core of the flint nodule was principally used for implement making.

A wide range of implements has thus emerged, among which may be identified a variety of series as hand picks, hand axes (single and double), hand choppers, knives and saws, borers, spear heads, (?) sickles, side scrapers, hammer stones, planes, gravers, spheres (somewhat angular), hooks, and miscellaneous small cutting flakes and pygmies. At Angmering-on-Sea intrusions include a sandstone axe head and a banded-chert implement, possibly an adze, with a cutting edge at one end and a point at the other; also some few neolithic implements.

The first series I shall describe consists of eight nodule implements, seven from Angmering-on-Sea and one from Worthing. These are similar to those found by Dr. E. Hugh Kitchin in the Bournemouth area. I use the name he gave to them. These are flints with the crust left, except at points where flaked. He considered his finds covered a wide range of time; and this seems to be the case here too, as some are patinated and others not. The few implements I have doubtfully called eolithic fall into this series.

The Clactonian flaked cores are from Angmering-on-Sea and have a rich patination.

An interesting series for which I selected a dozen specimens out of a larger number consists of what I have called 'worm-eaten' flints. They are deeply indented and the material is most refractory. Nevertheless implements were produced in the same technique as in the main body of the collection. The difficulties of excrescences and deep indentations were successfully overcome, especially as regards the latter, by ignoring their presence. The result is in some cases a veritable *tour de force*. There are what are intended for spear heads, (?) an adze, beaked implements of rostro-carinate type, a borer, a side-chopper, and axe head, (?) a plane, and a double-tailed implement as if for scraping down a pole to size. All this series comes from Angmering-on-Sea.

Another feature from the same locality, where numerous finds are of mint-like sharpness, is a series of crude implements, many of them picks, which have suffered from abrasion. They must for that reason be assigned a position among the oldest. The sharp edges of the facets are worn down, not necessarily on all sides. Whether the cause was moving ice requires further consideration.

As to the various classes of implements, there is an axe weighing 5½ lb., and measuring 194 mm. × 150 mm. × 70 mm. It is a natural block thinning towards what was adapted as a broad cutting edge. At the butt end a vertical cutting edge was contrived. It might have been used for killing elephants or other large animals. The knives and saws consist of a flint with a flat cleavage surface on one side, a rougher one on the opposite side, and crust left on the back. In one specimen there is clearly right and left chipping to make the saw edge. A fine and unique specimen is from the Worthing shore, measuring 208 mm. × 57 mm. × 30 mm. There is a gradually thickening blade which is about three fifths of the total length and 40 mm. wide with two edges. The handle widens abruptly, and there is no crust. A claw-shaped knife from Angmering-on-Sea, with flanged sides, measuring 95 mm. × 72 mm. × 21 mm. is also an interesting specimen.

The borers are of three kinds. A common form has a broad flattened point projecting from the middle of a long edge. Judging by the varying patination, this kind had a long time-range. The points of others are rectangular or prismatic, and at Angmering-on-Sea are found a number of water-rolled beach flints hacked to the latter specification, their altered texture being helpful in this respect. Other points are more suitable for boring small holes.

Seven spear heads show some waisting near the base. One is especially outstanding in this respect. They, too, have in most cases one flat surface. In two or three flints, crescentic cutting edges may suggest their being sickles. The planes are of various shapes, specimens with a 'two-humped camel back' being among them. The plane surface is in some cases of a perfect smoothness. The 'steep-nosed' type of plane is common. Two hooks from Angmering-on-Sea, of thin tabular flint, the larger 118 mm. × 35 mm. × 20 mm. would suggest use as harpoons were they sharper.

The range in size of these implements is considerable, extending from the 5½ lb. axe, some hand picks being nearly as large, down to small borers and knife-like flakes, and to minute flint points half an inch long which might have served as gravers. A further feature is that some of the implements have a dual use, some of the knives or saws having a point as well as a cutting edge. As to the Worthing shore flints, they are commonly stained a blue-black, while a few are ochreous, which may only be on one side. Some have serpulæ and coralline growths on them. From the known history of the shore they cannot have been very many centuries under water, and that only at high or half tide. Mr. Wills considered he had found two hearths, around which he made most of his finds. He also considered knapping had been done on the spot. There were difficulties in examining a particular spot. The shifting sand on the chalk rock would for a few days facilitate the work, and then the site might be buried even for years.

In going over the many hundreds of flints brought in by Mr. Stevens, I was fortunate in finding two implements which had on them secondary growth, a comparatively rare occurrence. As the growth was on the sharp edge produced by flaking, a time value is forthcoming. I had not long before found a natural flint in a newly cut trench on a ridge near Cissbury also with such a growth on it, and all three specimens are now in the British Museum (Natural History).

Several industries may be tentatively identified from these collections. There was especially hunting and the preparation of skins. Agriculture cannot be entirely ruled out. Woodworking is also indicated, as there are stones suitable for the sawing and scraping of sticks and boring the wood. These early folk presumably lived in houses of some kind, a supposition all the more tenable seeing that there were no caves or other natural protection for them. The grouping of the flints would further seem to indicate village life.

Connexion with the flint industry on the downs is slight, as the industry up there is mainly neolithic, though the implements be not ground or polished. The mining operations on the chalk downs in search of good flints, which possibly did not begin before neolithic times, were elaborate. Shafts were sunk and galleries driven. The core of the flint nodule was wanted as opposed to the outer part used by the early coastal plain inhabitants. These latter could occupy the plain during the glacial period or periods when the hill tops were under ice or snow. In later ages when the névé disappeared the hills were preferred for living on to the damp and forested lowlands.

The discoveries of Mr. Stevens and Mr. Wills are of great interest. It is not possible in a short article to enter into more detail. They will, however, serve to shed a new light into the darkness enveloping palæolithic man on the Sussex coastal plain.

FORTHCOMING EVENTS

Saturday, April 18

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Federation of British Industries, 21 Tothill Street, London, S.W.1), at 3 p.m.—Mr. P. P. Eckersley: "Future Developments in Communication Technique".

Monday, April 20

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. E. Ambrose: "The Distribution of Electricity" (Cantor Lecture, 1). (Subsequent Lectures on April 27 and May 4.)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Major the Hon. R. A. B. Hamilton: "Six Weeks in Shabwa".

Tuesday, April 21

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. M. G. Kendall: "The Future of Statistics".

Wednesday, April 22

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (JOINT MEETING WITH THE GEOLOGICAL SOCIETY OF LONDON) (in the Geological Society's Rooms, Burlington House, Piccadilly, London, W.1), at 3 p.m.—"Some Aspects of Geophysical Survey". Dr. J. M. Bruckshaw: "Some Factors limiting Geophysical Prospecting"; Dr. A. F. Hallimond: "Magnetic Explorations of the Geological Survey"; Prof. V. C. Illing: "Geophysics Applied to Oil Geology"; Dr. D. T. Germain-Jones: "Seismic Refraction Technique"; Prof. O. T. Jones, F.R.S.: "The Relation of Geophysics to Geology".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 4.30 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1940 to November 1941"; Dr. Maung Po E: "The Foreshadowing of the Rainfall of Burma".

Thursday, April 23

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.15 p.m.—Annual General Meeting; Presidential Address; Symposium with demonstrations on the Photographic Reproduction of Documents.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1) at 4.30 p.m.—Sir Arthur Keith, F.R.S., will exhibit Cranial Casts of South African Anthropoids, discovered by Dr. R. Broom, F.R.S., possessing Characters hitherto regarded as Human. Mr. R. E. Smith and Prof. C. N. Hinshelwood, F.R.S.: "The Detection and Inhibition of Free Radical Chain Reactions". Mr. W. S. Bullough: "The Starling and Foot-and-Mouth Disease".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Dr. O. E. Buckley: "The Future of Transoceanic Telephony" (Thirty-third Kelvin Lecture).

Friday, April 24

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, London, Adelphi, W.C.2), at 1.45 p.m.—Sir Hassan Suhrawardy: "The Development of Medical Education in India".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. C. H. Lander: "A Review of Recent Progress in Heat Transfer" (to be followed by a Discussion).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ENGINEERING ASSISTANT TO THE STAFFORDSHIRE POTTERIES WATER BOARD—Mr. P. Wilkinson, Engineer's Offices, Albion Street, Hanley, Stoke-on-Trent (endorsed 'Senior Engineering Assistant') (April 22).

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Registrar, University College of Swansea, Singleton Park, Swansea (April 22).

PRINCIPAL of the Durham Road Senior Technical and Commercial Evening Institute and Day Technical Classes—The Director of Education, Education Offices, Prince Consort Road S., Gateshead 8 (April 24).

ASSISTANT MASTER TO TEACH MATHEMATICS AND ELEMENTARY SCIENCE in the Junior Technical School—The Secretary for Education, Tudor House, Friar Street, Worcester (April 25).

UNIVERSITY CHAIR OF OIL ENGINEERING AND REFINING (PETROLEUM TECHNOLOGY)—The Secretary, The University, Edmund Street, Birmingham 3 (May 9).

UNIVERSITY READERSHIP IN ORGANIC CHEMISTRY tenable at London (R.F.H.) School of Medicine for Women—The Academic Registrar, University of London, Richmond, Surrey (May 12).

UNIVERSITY CHAIR OF RADIOLOGY (THERAPEUTIC) tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (May 26).

SECOND ASSISTANT PORT ENGINEER by the Iraq Government for the Basrah Port Directorate—The Central Register, Ministry of Labour and National Service, Queen Anne's Chambers, Tothill Street, London, S.W.1 (quoting E426).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Old World and the New Society: a Report on the Problems c War and Peace Reconstruction. Pp. 32. (London: The Labou Party.) 3*d*. [11

Tin Research Institute. Publication No. 108: Surface Hardness c Metals. By Dr. Bruce Chalmers. Pp. 20+2 plates. (Greenford: Ti Research Institute.) [12

Institution of Gas Engineers. Communication No. 242: 2n Report of the Chairmen's Technical Committee, 1940–41. Pp. 1 Communication No. 243: 18th Report of the Gas Education Committee, 1940–41. Pp. 36. Communication No. 244: Institution Ga Research Fellowship Report, 1939–40. Pp. 36. Communication N 245: Institution Gas Research Fellowship Interim Report, 194 Pp. 32. (London: Institution of Gas Engineers.) [12

Gas Research Board. Communication GRB4: 2nd Annual Repo of the Council of the Gas Research Board. Pp. 16. Communicatio GRB5: 32nd Report of the Refractory Materials Joint Committe Pp. 92. (London: Gas Research Board.) [12

Young Farmers' Club. Booklet No. 2: Bee Keeping. By Regina Gamble. Pp. 48. 6*d*. Booklet No. 6: Grassland. By J. O. Thoma Pp. 50. 6*d*. Booklet No. 8: Goat Keeping. Pp. 48. 6*d*. Bookle No. 9: Garden and Farm Insects. By A. J. A. Woodcock. Pp. 4 6*d*. (Radlett: National Federation of Young Farmers' Clubs.) [12

University of London: University College. Annual Repor February 1941–February 1942. Pp. 47. (London: Taylor an Francis, Ltd.) [13

London Shellac Research Bureau. Technical Paper No. 21: Re action of Lac and Lead Tetra-Acetate. By Dr. B. S. Gidvani an Dr. R. Bhattacharya. Pp. 16. Technical Paper No. 22: Reactio of Lac with Metallic Oxides, Part 1. By N. R. Kamath and D R. Bhattacharya. Pp. 16. (London: London Shellac Researc Bureau.) [13

British Rubber Producers' Research Association. Publication N 14: The Number of Configurations of a Cooperative Assembly. B A. R. Miller. Pp. 109–124. (London: British Rubber Producer Research Association.) [16

Proceedings of the Royal Irish Academy. Vol. 47, Section A, No 3, 4: Exchange and Spin, by Erwin Schrödinger, with a Note b James Hamilton; The Factorization of the Hypergeometric Equatio by Erwin Schrödinger. Pp. 39–54. 1*s*. Vol. 47, Section A, No. 5 A Class of Groups. By Ernest Best and Olga Taussky. Pp. 55–6 1*s*. Vol. 47, Section B, No. 6: Salmon of the Owenduff (Ballycroy River. By Arthur E. J. Went. Pp. 161–178. 1*s*. Vol. 47, Sectio B, No. 7: Excretion of Glucose by the Rabbit Kidney, Part 3: Th Influence of Urethane, Insulin, and Adrenalin on the Kidney Thre hold for Glucose. By T. W. T. Dillon and S. Feric. Pp. 179–20 1*s*. 6*d*. Vol. 47, Section B, No. 8: Characteristics of Irish Soil Type Part 1. By Patrick H. Gallagher and Thomas Walsh. Pp. 205–250 plate 3. 2*s*. 6*d*. Vol. 47, Section B, No. 9: The Influence of Tem perature on Animal Oxidation. By J. M. O'Connor and D. K O'Donovan. Pp. 251–274. 1*s*. Vol. 47, Section B, No. 10: Expan sion of Monomolecular Layers of Mixed Saturated Fatty Acids. B F. Kane. Pp. 265–274. 1*s*. Vol. 47, Section B, No. 11: *Thomondi* a new Trilobite Genus from Co. Clare. By J. C. Harper. Pp. 275 278+plate 4. n.p. Vol. 47, Section B, No. 12: The Granite Dri near Brittas, on the Border between County Dublin and Count Wicklow. By A. Farrington. Pp. 279–292+plate 5. 1*s*. (Dublin Hodges, Figgis and Co., Ltd.; London: Williams and Norgat Ltd.) [23

Other Countries

Field Museum of Natural History. Zoological Series, Vol. 22, No. The Amphibians and Reptiles of British Honduras. By Karl P. Schmid (Publication 512.) Pp. 473–510. 40 cents. Zoological Series, Vo 27: Papers on Mammalogy. Published in honor of Wilfred Hudso Osgood. (Publication 511.) Pp. 395+12 plates. 3 dollars. (Chicago Field Museum of Natural History.) [

Forest Bulletin No. 98: An Indirect-heated Internal-fan Furna Kiln (Blower-cum-Furnace Kiln) for Drying Packing-Case Timbe By M. A. Rehman, assisted by Inder Kishen Kapur. Pp. vi+7+ plate. (Delhi: Manager of Publications.) 5 annas; 6*d*. [1

Durban Museum and Art Gallery. Annual Report for Municip Year 1940–1941. Pp. 12+4 plates. (Durban: Durban Museum an Art Gallery.) [16

South Australia: Institute of Medical and Veterinary Scienc Third Annual Report of the Council, July 1940—June 1941. Pp. (Adelaide: Institute of Medical and Veterinary Science.) [1

Imperial Council of Agricultural Research. Miscellaneous Bullet No. 47: Definition and Characteristics of Dhanni and Khillari Catt and Nili, Ravi and Surti Buffaloes. Pp. iv+20+14 plates. (Delh Manager of Publications.) 1.6 rupees; 2*s*. [1

Science and Ethics. 1: A Biologist's View; 2: The Hindu Vie By D. V. Gundappa. Pp. 32. (Bangalore: Karnataka Publishin House.) [19

U.S. Department of Agriculture. Circular No. 615: Studies on t Control of Cabbage Caterpillars with Derris in the South. By W. Reid, Jr., C. E. Smith, L. B. Reed and C. O. Bare. Pp. 27. 10 cent Technical Bulletin No. 788: Relative Effectiveness of Acid Le Arsenate and other Materials as Stomach Poisons for the Larvae the Japanese Beetle. By Walter E. Fleming. Pp. 32. 10 cent (Washington D.C.: Government Printing Office.) [2

U.S. Office of Education: Federal Security Agency. Vocation Division Bulletin No. 212 (Occupational Information and Guidan Series No. 5): Occupational Information and Guidance Bibliograph 1937–38. Compiled by Pedro T. Orata assisted by Waldo B. Cookin ham. Pp. xi+521. (Washington, D.C.: Government Printing Office 55 cents. [23

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EDUCATION FOR CULTURE AND CITIZENSHIP

THERE has been of late much adverse criticism of the way in which the sciences are taught in schools and colleges of Great Britain. This criticism takes a variety of forms. It is asserted that the work is too specialized, that it is too academic, or that too much attention is devoted to the teaching of technique. The chorus of complaint may indicate that there is something wrong, but it does not follow that the fault is entirely with the teachers ; it is just as likely to lie with those who complain, and the danger is that their specious criticisms may influence the teaching in a wrong direction. If biological teaching, for example, is centred around man, as many educationists would have it, that teaching is bound to become subjective, and trouble is certain to arise (see p. 457). It is essential that the objective attitude should be cultivated and developed as fully as possible in all branches of science teaching.

Furthermore, some schools have taken up biology, for example, because it seemed to be becoming 'fashionable', and the school must be in the swim. An economic motive arises from the increase in the number of entrants into the medical profession, and from an erroneous idea that there is a large number of research posts in biology. It seems then that this subject has got into the curriculum partly upon sufferance and partly because a demand for it has arisen in the public mind. It is only here and there that it is taught as a worthy subject which provides appropriate training for a certain type of mind (a type more common than is often appreciated), and there is not as yet a sufficient realization that the training is as valuable as that afforded by a study of the so-called more exact sciences.

All sound teaching of the science subjects rests on several things, but above all on careful and accurate observation. Such careful and accurate observation is not within the capacity of an untrained observer ; the students have to be taught to observe. Critical observation breeds a critical habit of mind and a capacity for using the information obtained by the observation. It provokes and promotes thought. A person trained in the habit of observation applies that habit to all with which he has to deal. Training in observation and in the habit of mind it engenders is one great contribution which science has to make to education.

To train students in accurate observation is a severe test of the teacher's ability. Many students, rightly and naturally, take much pleasure in making preparations, in analysis, in dissection and in compiling books of drawings, but these things by themselves are not science. From the over-emphasis of technique and the memorizing of too many facts comes the widespread and erroneous opinion among those who know little and care less about science that skill in technique and the knowledge of a long list of forbidding terms make up the whole of science. It should be recognized that these are but means to the end, which is training in the art of close and accurate observation. There is a value also in the confidence the student gets from his ability to do something in a workman-like manner. Sound work in the sciences acts as a protection against over-hasty generalizations. The diversity which is one of the charms of plants and animals, for example, stimulates curiosity and keeps the mind alert. It makes the observer watchful, and it encourages a habit of mind which demands evidence rather than unsupported statements.

Practical work is important, but it must be kept in correct perspective. It must be within the capacities of the students; for example, in biological work it will be mainly morphological, with a functional bias. Elaborately developed cytology and physiology do not provide suitable practical exercises, and consequently information has to be got from books rather than from personal experience.

There are special difficulties in teaching biology to town-bred children, though this is not true of all the sciences. While the town dweller is denied full access to much of scientific interest, yet he often has access to museums, zoos, gardens, works and factories which can serve him well, and could serve him better if close co-operation were established between controlling authorities. The cinema is becoming a more and more efficient instrument of instruction, and it can and should be used to supply something at least to compensate the disadvantages inevitably suffered by the student living in a large town. But the films must not take the place of direct work.

It is probably true that the greatest hindrance to science teaching is the examination system. Rightly or wrongly, teachers may consider it their main task to get their students through examinations, and if they do not themselves think so, that point of view may be imposed on them either by the administration or by public opinion working through the administration. The objective becomes the piling up of examination successes, and the bigger and more impressive the pile, the better the work of the school and of the teacher is supposed to be. All that being so, it is not remarkable that the schools may aim, not merely at getting as many examination successes as possible, but may seek to acquire additional merit by pushing as many pupils as possible through the stiffest and showiest examinations available. The subjects certainly suffer, and there is more than a suspicion that the welfare of the students may be sacrificed to the chance of academic successes for the school.

All this reacts on the mentality of the students, who get more and more the idea that the aim of their schooling is to enable them to pass examinations; the more stupid, and a very few with an abnormal dose of common sense may escape this. To pass the more showy examinations, specialization is thought to be needed, and this thought is gaining ground to such an extent that there is even talk of introducing research into the schools, a charming illustration of a tendency not unknown in educational schemes, that of starting a building with the roof and working downwards. Following this supposed need for specialization, we find harassed teachers attending scientific meetings, hastily grabbing up such crumbs as they can snatch, and decanting the fragmented results of recent research on their unfortunate students in the hope that this will scrape together a few more marks.

It seems clear that we must have some form of school-leaving examination to provide a test of how the machine is working, and to give an aim, for unless there is an objective the work is likely to be diffuse and pointless. But the present custom of having two such examinations, one at a lower and one at a higher level, is to be deplored. One examination should be sufficient, and it should be organized so as to provide an adequate test of the general education of candidates aged between fifteen and sixteen years. If the pupils stay in the school beyond the age of sixteen, they should not then be pushed on to specialized work; that work should be done in technical institutions or in universities.

Older students who have given evidence of possessing satisfactory general competence should be allowed, during the later part of their school life, a temporary respite from examinations, and should be able for at least a year to pursue with some freedom whatever line of learning attracts them. That liberty, following several years of preparation for the School Certificate examination, would loosen up their mental joints and enable them, before they are caught up into industry or into a period of specialized training for a profession, to look around somewhat and perceive that scholarship is something more than textbooks and formal lessons.

During this 'sabbatical year' the student might look aside somewhat from those subjects in which he may afterwards specialize. This would be the opportunity for the future student of science to give some time to arts subjects, and for the future arts student to profit from instruction in science; both groups would benefit from some mathematics at this stage. At present, the student on the science side may be stultified by the repetition of the same kind of chemistry and physics year after year during his school life. He could profit well from instruction in the use of English during this period of recuperation (see p. 454). For some reason the writing of essays now seems to be taboo, and the study of English literature does not seem to be favoured. All this may explain the frequent and shocking illiteracy of students entering the universities. Let the student in this year of his freedom dip, as he feels moved, into the glories of English literature, but let there be no set books, no commentaries and no annotated editions.

If, for many, the older classics are too heavy going, why not use the moderns whose outlook is more in tune with our own? Let the cinema be studied critically; despite the welter of nonsense, there is much that is excellent. The gramophone and the radio will give an introduction to music and musical appreciation, and there should be ample time for history and geography, both studied with an eye to modern affairs and the problems of citizenship. Lastly, there should be the conversational study of at least one foreign language, French, German or Spanish, to get the student to lose his self-consciousness and to talk. Physical training is also desirable at this stage.

At the end of the 'sabbatical' year, those students who intend to train for the more technical side of commerce or for one of the professions should proceed for their specialized training to an appropriate college, where they would be freed from the school atmosphere and where they could begin to make wider contacts than are possible in a school. Their preliminary training for an examination of intermediate grade should not extend over more than one academic year. That period is amply sufficient for any college student of ordinary ability and industry, and there are no advantages, and very marked disadvantages, in spreading that phase of the work over two years, as is commonly done in schools. By taking the preparation for the first university examination out of the schools, time would be provided in the schools for some final inculcation of general culture, and, if one may judge from the results of certain public examinations, the transfer of the intermediate work to other institutions would materially improve the chances of the students in passing their preliminary professional examination at the first attempt —a very desirable thing.

The idea here expressed is to provide a break between the generalized and the specialized periods of the education of a pupil, not merely to give an opportunity for the acquisition of some general culture, but to mark that there is at this stage a change in the character and conditions of the work. The non-specialized training in particular could and should be made to support some simple instruction on the more obvious connexions between science and ordinary life. Thus the adolescent, before he is plunged into the task of completing his professional training and before he is immersed in establishing his position, is given the opportunity of getting a general view of things which a year of freedom from training for an examination would offer.

The aim of education is not to get students through examinations. When a child has spent several of his most impressionable years in being trained to that end, it is not surprising that he finishes with an altogether wrong idea of the importance of examinations. A transitional period between school and college, with no examination in immediate prospect, might well awaken broader ideas and broader ideals, and so help on the development of that most desirable type of citizen, the man who has self-respect because he can think independently and can express himself clearly to others. Any ordinary man would be outraged if it were suggested to him that someone should eat his dinner, digest it, and then pass it on; few ordinary men are as yet outraged because their mental food is commonly treated in this fashion. This is but one of the many ideas which might become more common with the wider diffusion of generalized teaching in science, and with that wider diffusion and the closer study of the impact of science upon society there may also come the realization that the present organization of human society is largely unscientific. Society cannot become a better thing for the average common man until it is in accord with the scientific principles which that man can appreciate and approve.

A SENTIMENTAL JOURNEY

Black Lamb and Grey Falcon

The Record of a Journey through Yugoslavia in 1937. By Rebecca West. Vol. 1. Pp. xi+653+16 plates. Vol. 2. Pp. vii+586+16 plates. (London: Macmillan and Co., Ltd., 1941.) 42*s*. net.

In the eighteenth century, it was a diversion for those who could afford it to travel in a post-chaise through foreign parts, and thereafter to publish a gossiping guide, more or less observant and outspoken. Some of these works have become classics, and the practice is happily not extinct. But now one must go farther, one may travel faster, and by appointment one can see more various people; one also writes more gaudily than Laurence Sterne.

Here is a minutely annotated narrative of a spring tour in Yugoslavia in 1936. Rebecca West, already proficient in fiction, biography, and criticism, had lectured there the year before, and was fascinated by the land and the people. Though, as she says, she "knew quite a lot of Hapsburg history", she "knew nothing about the South Slavs"; so her industry has been great. But on her second visit she had a Government car with radio—a novel type of traffic-signal—a husband replete with common sense and restoratives, and as courier a Serbian official, Constantine, of Jewish descent, and resilient self-esteem, "one of the most gifted and learned men in Europe"; so the Serbian point of view was fully, though not exclusively, supplied. Of the Croat aspect of Yugoslavian affairs she is less well informed; her rare references to the Greeks are unsympathetic; she has no good word for Bulgarians, and she deliberately omits from her bibliography certain writers with whom she disagrees. But she liked the Albanians she met, and heard well of Albanians in general from her Serbian friends, and from Gospodin Mac, the wise manager of the Stan-Trg mine. As her own opinions incline to the Left, it was candid to describe as the most happy and prosperous community, where age-long feuds seemed to fade into mere neighbourliness, one created by foreign capitalists and governed by a Scottish dictator. Part of the trip was marred by Constantine's German wife, a repulsive character, cruelly drawn; and something went wrong, too, with Constantine; he was already ill at ease before he fades out of the book. Among all these aids and handicaps, two things are obvious: the ingenuous good nature of all classes of people, except a few political agents, and the personal achievement of Rebecca West and her husband, in eliciting so much intimate self-revelation and local commentary on what they were so fortunate as to see. Of the dialogues, some recall Thucydides' admission that his "speeches" were what might appropriately have been said.

Though the book, of some 1,200 pages, grows longer as one reads it, and has defects inherent in its circumstances and its technique, it has value for several reasons. First, it is a brilliant kaleidoscope of Balkan landscape, reviving treasured memories by its bold characterization of types, and insistence on the land's austere grip over man's fortunes, and on other men's devastation of laborious achievement. Some of this word-painting is difficult, like the pea- and plum-coloured landscapes that are skyed at the Academy; for colours, forms, and processes are oddly named—"savage" green, "sissy" flowers, "virile" water, "anfractuous" landscape, "enchanting camber" (the *profile* of an old bridge). Lake Scutari may be "earth's self-drawn ideogram, expressing its monstrosity" ooze-bound in greenish jelly (2, 426), but it is not a "fiord". Musical notation reinforces visual; internal disorder and sex-appeal lose vividness with iteration; mother-earth gives birth and is raped inordinately. The German girl condemned to an *Arbeit* on the works of West had scope for etymology as well as for æsthetic.

Then, of the people themselves, their racial types, and the thoroughbred humanity and physical grace of the best of them, there is direct and minute appreciation, and recurrent comparison—not new, but welcome confirmation from a fresh eye—with classical and Byzantine models, which are themselves only ideal because they embody just such personal experiences of contemporaries who could draw or write. Often we are on the hillside, not in Macedonia or Montenegro, but in old Ithaca, or with Achilles in his wrath.

Among these graphic glimpses of things seen and heard in such surroundings, the story, as Herodotus says, "loves parenthesis", groping back into medieval and earlier obscurity to answer Peterkin's question, "What they fought each other for"; and the answers lose nothing by being given before the tomb, or the church, or on the battlefield, which is landmark and datemark in one. Sensitive appreciation of Byzantine architecture and fresco-painting, and deeper sympathy than some historians have shown with Byzantine worship, enhance the perspective of secular events; many of which indeed ceased to be secular while the enemy was Islam, as they ceased again (so soon after!) when Cross met Swastika.

This leads to another and larger aspect of the book. In the spring, and especially at Easter, Orthodox belief finds expression in ritual, none the less potent, in the hands of a Bishop Nicolai, because much of it is not Christian at all. Here the "Black Lamb" of the title, a victim of St. George's Eve (2, 198*ff.*) provokes hysterical commentary, while Moslem incubation is condoned; and the "Grey Falcon" which brought King Lazar the choice between a temporal kingdom and an eternal (2, 292*ff.*) reveals him as "a member of the Peace Pledge Union" in distinguished modern company, and leads to a pendant onslaught on their political philosophy, preparing the way for an 'epilogue' to the whole book (2, 464*ff.*). These, like the fantasia on a foul latrine, and other incidents, are parenthetic writing at its weakest. But there is an adequate index.

There emerges—what has been hinted throughout the narrative—the writer's essential motive. After one of the Balkan conferences in 1913, one of the conspirators, congratulated on apparent settlement of claims, is said to have replied, "Well, there is always Serbia". It was the murder of King Alexander that roused Rebecca West to a sense of peril for herself and for all that she valued in this world. It was to analyse her own fears, and the motive for such crimes, that she devoted her gifts of eye and heart and pen; and she has brought her story on to the tragedy of April 1941, when the "Grey Falcon" came again. Much that she has written may be disputed now, some things may be refuted with fuller knowledge than hers. But she has seen much, studied widely, and thought hard, and it is not possible to read her indictment of the evils which have made South Slav fortunes so tragical, without realizing that what has happened in Yugoslavia does not differ in kind from perils that beset us all.

J. L. Myres.

AIDS TO AIR NAVIGATION

Astrographics, or First Steps in Navigation by the Stars

A Primer for the Airman Cadet. By Prof. Frank Debenham. Pp. v+118. (Cambridge: W. Heffer and Sons, Ltd., 1942.) 7*s.* 6*d.* net.

The Observer's Planisphere of Air Navigation Stars

By Ft.-Lieut. Francis Chichester. (London: George Allen and Unwin, Ltd., 1942.) 2*s.* 6*d.* net.

THE most reliable method of air navigation is by means of the celestial bodies. The time that can be devoted to training the air cadet in astro-navigation is necessarily limited. The air navigator can acquire all that he needs to know without much knowledge of mathematics, and can work more or less by rule of thumb; but the results are bound to be more satisfactory and the risks of error lessened, especially in an emergency, if he fully understands what he is doing. Prof. Debenham's little book has the commendable purpose of providing an easy approach to the principles involved by the use of graphic methods. A stereographic projection chart, with a matt celluloid rotatable disk, is provided to enable the spherical triangle to be solved approximately; stereographic scales are also provided, which make a somewhat greater accuracy attainable. These graphical methods undoubtedly give a greater insight into what is being done than is possible by the routine use of mathematical formulæ, and the cadet who studies Prof. Debenham's volume with understanding cannot fail to benefit from it.

A well-chosen series of exercises is added, to which solutions are given.

The book is unfortunately marred by a number of statements that lack precision or that are badly expressed, such, for example, as the following: a magnetic bearing is measured from a magnetic pole, which attracts compass needles, but does not stay in one place; the equator encircles the largest part of the earth; the parallels of latitude are equidistant from each other; on June 21 the sun's path is overhead all day along the Tropic of Cancer. It is stated that sidereal time is "a very useful kind of time, easily checked by observing any star's passage over the meridian, and with no tricky corrections to be applied"; this is not correct, for there are true sidereal and uniform sidereal times, just as there are apparent and mean solar times. The essential features of the Air Almanac are not explained; it is stated that "the airman wanted something handy in size, easy to understand and not burdened with too great a precision", yet the Air Almanacs for a whole year necessarily occupy a greater compass than the Abridged Nautical Almanac for seamen.

The use of haversine formulæ and tables could well have been omitted and a brief description given of tables providing a direct solution of the spherical triangle when an assumed position has been adopted; such tables are much more convenient and suitable for use in the air than logarithmic haversine tables.

Every air navigator should be able to identify with certainty the stars that are used in the Air Almanac, not only on dark clear nights but also on moonlight nights and with broken cloud. The special air navigation stars have been selected from among the brightest stars so as to give a reasonably good distribution over the sky. In the planisphere prepared by Flight-Lieutenant Chichester, these stars are shown, with sufficient additional bright stars to aid in their identification. The twenty-four principal stars, the altitudes and azimuths of which are tabulated for different hour-angles and declinations in the Air Navigation Tables, are indicated by name, the remaining navigation stars by their numbers in the Air Almanac, while the other stars shown are numbered and their names given in a key. The planisphere shows the air navigation stars visible at any time of the night or year to observers in latitudes 50° N. and 35° S. It should be a great help to air cadets in learning to identify the stars required for navigation.

H. Spencer Jones.

UTILIZATION OF STATISTICS IN RESEARCH

Statistical Methods for Research Workers

By Prof. R. A. Fisher. (Biological Monographs and Manuals.) Eighth edition, revised and enlarged. Pp. xv+344. (Edinburgh and London: Oliver and Boyd, 1941.) 16*s*. net.

Since its first appearance in 1925 Prof. Fisher's book has become the standard manual of statistical practice for research workers throughout the English-speaking world, and new editions continue to be called for. This eighth edition follows the same lines as its predecessors, which have themselves grown from the first mainly by the insertion of supplementary material throughout the book, not by structural alteration.

One of the signs of the success which the book has enjoyed is a change in methods and emphasis over the last seventeen years which would have justified a rather more drastic revision. The author evidently feels this himself, for in the preface he excuses himself from "The difficult task of a fundamental re-arrangement" on the grounds that "it is of real value to understand the problems discussed by earlier writers and to be able to translate them into the system of ideas in which they may be more simply or more comprehensively resolved". Perhaps so, but we may hope that on some future occasion Prof. Fisher will be able to find the time and opportunity to remould the book a little nearer to the heart's desire.

In some respects this is a difficult book, partly because of Fisher's condensed style and partly for a more important reason. The theory of estimation and the exact tests of significance with which it deals are based on ideas and derived by mathematics which are quite outside the ambit of the average research worker in the so-called natural sciences. It would have been impossible to give anything like a complete account of the theory in a monograph restricted to method; and thus the author was practically compelled to the course which he finally adopted, and to describe only the technique of his methods and to exemplify their use. In consequence the reader has to accept important results without proof and often without any hint as to how they were derived or precisely what hypotheses underlie them. If he is sufficiently interested and has the leisure to look elsewhere for the basis of the authority so much the better; but he will not find it in this book, and it is difficult to see how Fisher could have provided it without expanding a relatively short handbook into a comprehensive treatise.

This raises the question how far the powerful methods of modern statistics can be properly applied without some conception, however general, of their rationale. Its importance is heightened by the fact that the book, though not intended as a course of instruction for statisticians, is often referred to as if it were. Fisher has, in fact, suffered from a want of self-control on the part of some of his disciples, who betray a rapturous and undiscriminating enthusiasm which would be out of place even at a promenade concert. This in turn has excited a certain amount of criticism of the book. Orthodox statistical teachers have expressed doubts whether Fisher's broomstick can safely be entrusted to any apprentice who can memorize an invocatory formula. It is replied that one can use a telescope intelligently without being an optician. It is retorted that only qualified practitioners are allowed to administer powerful drugs. This sort of argument trails indecisively through a good deal of the statistical literature of the past fifteen years, but the whole question is one which might well be seriously discussed. In a large laboratory the difficulty may be overcome by the employment of a statistical specialist, and perhaps as research becomes more centralized the problem of the individual research worker who has to be his own statistician will disappear. But the question how far a knowledge of statistical *theory* is an essential part of the equipment of a research worker remains unanswered; it is a problem which could with advantage be studied by those responsible for the training of such workers.

However that may be, the influence of "Statistical Methods" on scientific method has been profound. To Fisher and his school goes the credit for having brought home to scientific workers two things. One is that the proper use of experimental data is itself a science which can be brought to a high degree of precision, even when the material is imperfect and the sample small. The second is that though in certain sciences and in certain classes of experiment error cannot be reduced, it can be controlled by experimental design. This latter lesson, indeed, has been inculcated by Fisher in a separate book and has not yet been fully learnt by research workers. It is a useful rule that statistical advice should be sought *before the experiment is carried out.* Most statisticians have met the case in which the results of an experiment could have been given a much greater significance, very often without additional trouble or expense, by adequate design at the outset of the inquiry.

Notwithstanding the interest aroused by the newer methods in statistics as applied to experiment, "Statistical Methods" has few competitors. To some extent this is due to the fact that it is largely a record of Fisher's own achievements, but that is not the whole story. The challenge of Fisher's ideas and his long record of success have made this book a sort of symbol of a new statistical creed and a banner around which his followers rally themselves. Research workers will long continue to buy this book, to wrestle with its ideas and to apply its methods to an ever-enlarging field of discovery.

M. G. Kendall.

PHYSICAL BASIS OF RADIOLOGY

Radiology Physics

An Introductory Course for Medical or Premedical Students and for all Radiologists. By Prof. John Kellock Robertson. (Textbooks on Physics.) Pp. xv+270. (London: Chapman and Hall, Ltd., 1941.) 18*s*. net.

THE applications of physics to medicine increase rapidly in number and scope, and there is great need of books which attempt to set forth the fundamental principles underlying these applications, either from the point of view of a fairly elementary student or from that of a more advanced worker in the subject. Prof. J. K. Robertson's book is addressed to the first of these possible audiences, and is a most welcome addition to the literature.

It is described as "an introductory course for medical or premedical students and for all radiologists" and represents a course of physics which is given to medical students at Queen's University (Kingston, Ontario) after their first-year preliminary training in physics. It is perhaps worth noting that the American Association of Physics Teachers is in favour of making the physics pre-requisite two years instead of one; this is a question which may well exercise those in Great Britain who are responsible for the scientific training of the medical undergraduate.

The book contains chapters on alternating currents, the production of high voltage, the "measurement and control of high tension voltage", cathode rays, positive rays and isotopes, Röntgen-ray tubes, valve rectification, general properties of X-rays, electromagnetic waves, measurement of wave-length of X-rays, secondary X-rays and absorption, Röntgen ray dosage, radioactivity, supervoltage tubes and high-speed particles, artificial radioactivity and high frequency currents.

The book is well written, though we may perhaps be allowed to protest against the title "Radiology Physics" or such phrases as "control of high-tension voltage" which sometimes occur, but such verbal infelicities are rare. Occasionally it seems that the order of certain sections might be altered with advantage, as for example the high-frequency current section, which might be brought forward into the earlier portion of the book dealing with electrotechnical matters, while the discussion of X-ray quality measurement and half-value layer would perhaps be more intelligible to the student if it followed the discussion of absorption and absorption coefficients.

In further editions of the book—and there should surely be others—the discussion on electromagnetic waves might also be expanded and more detail included. Possibly the difficulty arises from the fact that the book is intended for use by those who are presumed to have had the first-year instruction, but standing alone it seems advisable to discuss the elements of infra-red and ultra-violet physics more fully and more fundamentally than is actually attempted. The section concerning the relation of focal spot to wave-length is also isolated and might advantageously be expanded.

The diagrams are generally very clear, simple and accurate, but in spite of the legend the bending of the positively and negatively charged rays towards the poles of the magnet (Fig. 141) is rather misleading. These details are, however, very small blemishes on an excellent book which covers a large amount of ground simply, clearly and accurately, and the author has rendered a considerable service to physics in medicine by writing it. There can be no doubt that it will be very generally used in the training of both undergraduates and medical radiologists.

W. V. Mayneord.

RUBBER AT A TURNING POINT?

Rubber and its Use

By Harry L. Fisher. Pp. xvi+128. (London: Macmillan and Co., Ltd., 1941.) 7*s*. 6*d*. net.

DR. FISHER's small work is a model of excellent compression. Avoiding side issues and technical minutiæ, the book gives a clear, accurate and balanced picture of the development and present state of rubber science and technology. All the usual topics of a popular descriptive work of this kind on rubber are present. There are chapters on early history, sources of crude rubber, the plantation industry, crude rubber itself—its nature, properties, compounding and manipulation in the various manufacturing processes. Novelties arising out of the relatively less familiar processes of latex manufacture are not omitted. There is a revealing outline of the main types of vulcanized rubber articles, and a few pages on synthetic rubbers and on the chemical derivatives of crude rubber bring the discussion into the most recent trends of development of the industry. Dr. Fisher has had seventeen years experience with the large American rubber companies and, as he states, extensive experience in lecturing to student groups; from these experiences he has compounded the correct ingredients for a popular work remarkably well. Good illustrations add interest for the lay reader.

The present crisis in rubber supplies, created by the over-running of the Far Eastern plantations by Japan, has brought rubber forcibly to every mind and makes the present book timely even if the crisis itself is no part of the text. The crisis indeed may well make this book the last summary of one particular epoch in the story of rubber. There is no question that the only way out of the impending rubber scarcity is by way of synthetic rubbers. Reclaimed rubber and vulcanized oil substitutes are emergency palliatives of the first importance, but the rubber industry cannot live indefinitely on reclaim and factice. We are thus destined in the coming decade, and perhaps for much longer, to extensive use of synthetic rubbers of several types aggregating possibly half a million tons a year when production reaches that figure in the next three or four years. Such a transformation of the rubber industry undoubtedly marks a turning point in its history of incalculable significance.

Both manufacturers and users of rubber articles will find fundamental differences between the coming epoch and that which is now closing. Whether we shall be able, or will wish, to return to presen practices in the future is a complicated technical and economic problem of which no one can foresee the ultimate outcome. Dr. Fisher's book may well live as an apt summary of an epoch not destined to return.

Nutrition and the War

By Dr. Geoffrey Bourne. Second edition, revised and enlarged. Pp. xii+148. (Cambridge: At the University Press, 1942.) 4*s*. 6*d*. net.

IN these days of fortress economics, a special responsibility should burden those who set out to give information about food to the multitude, and it is only fair that their books should be submitted to searching criticism. From such a stern test Dr. Bourne's book emerges certainly not unscathed but with its fabric still fundamentally sound and a prognosis of useful service. It is entertainingly and well written and in places surprisingly up to date; its successive chapters deal in simple language with energy and food; proteins, fats and carbohydrates; vitamins; minerals, and nutrition in war-time. Nearly half the book is taken up by tables setting out the calorie, protein, carbohydrate, fat, mineral and vitamin content of a variety of products.

The advice given in the book is on the whole sound. At times, however, it is detached from reality, as in the author's unnecessary insistence on the paramount importance of citrus fruits, which are almost unobtainable, and his failure to indicate the excellent though more homely sources which everyone can produce in garden or allotment. A more serious point is the lack of appreciation that it is not so much the richness of a product in any given food factor as the amount consumed that matters in the end. This leads to the strange selection of curry powder as the best source of iron, and of 'Marmite' as nearly the best source of calcium. Alcohol gets an unexpected pat on the back and one almost fears that this misinterpretation of Mitchell's work might lead an enthusiastic planner of the family diet to prescribe it to children to make them grow faster and put on flesh. Fortunately, the commodity is in short supply. The weakest part of the book are the tables, which contain many mistakes. (Watercress and tomatoes are given as poor in vitamin A, but oranges and wholemeal flour are classed as fairly good; dried peas, beans and lentils are recommended as a source of vegetable fat, and so on.)

Frankly, Dr. Bourne will have to study his Fixsen and Roscoe and his McCance and Widdowson and do some drastic revising. The book is worth it and one looks forward to an improved third edition. Let us hope that by then a change in the title will also be needed.

S. K. KON.

Tables of Physical and Chemical Constants

And some Mathematical Functions. By Dr. G. W. C. Kaye and Prof. T. H. Laby. Ninth edition. Pp. vii+81. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 18*s*. net.

N the last thirty years this valuable set of tables has become so indispensable in the physics laboratory that every laboratory boy knows what to get when asked for "Kaye and Laby". If authors' names alone were to be used, accuracy would demand that far more than two be mentioned, for the original authors adopted the wise policy of securing the help of many others. As this edition, the ninth, was passing through the press, Dr. Kaye died and the Physics Department of the National Physical aboratory gave a final inspection to the text and prepared the index. Prof. Laby, who took no part in the preparation of the eighth edition, has re-ritten for the present edition the tables dealing ith units and dimensions, electrical units, conversion factors, mechanical equivalent of heat, velocity of light, general and atomic constants, α-rays, radioactivity, isotopes and arrangement of electrons in atoms. In one section the tables are ahead of time, because they include the electrical units originally proposed for adoption as "absolute" from January 1, 1940, by the International Electrotechnical Commission. The War upset the plan for general adoption.

The publishers have managed to find good paper for this edition. Twenty pages have been added to the book, and four shillings to the price.

W. H. G.

Mathematics for Technical Students

By A. Geary, H. V. Lowry and Dr. H. A. Hayden. Part 3. Pp. viii+393. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1941.) 8*s*.

THIS is the third part of a series designed to provide the basic mathematical equipment for technical students, and to meet the requirements of the national certificate courses in engineering, building and chemistry. Each volume is planned to cover a year's work; the book under notice is thus intended to provide the necessary subject-matter for third-year students.

After a useful chapter on revision, the text begins with the progressions, binomial series, graphs of exponential functions, and the trigonometric addition theorems. The ground is accordingly well prepared for the calculus which follows. The modern method of developing the principles of differentiation and integration, side by side, is well carried out, and illustrated by applications to mechanical and electrical engineering. The final chapters are devoted to complex numbers, with applications to alternating currents, and alignment charts. There is a valuable summary of formulæ followed by a number of specimen examination papers. The student is well provided, at the ends of each chapter, with exercises for practice, to which answers are supplied. The book also includes an index and the usual set of tables.

Intermediate Algebra

By Neil McArthur and Alexander Keith. Pp. x+356. (London: Methuen and Co., Ltd., 1942.) 8*s*. 6*d*.

THIS excellent book reveals the rapid strides which algebra has made in recent times. A few years ago, "Higher Algebra" would most probably have been the appropriate title. The course is designed primarily for use in school and first-year university classes, the students of which have previously covered the work required for the first school certificate examination. The text deals, in a comprehensive way, with polynomials, partial fractions, equations, including determinants, indices, logarithms, simple series, graphs and the binomial theorem. The authors have provided a stimulating introduction on the basis of the course which should give the student an intelligent interest in the subject. Mention should also be made of the important chapters on graphs and the method of differences which lead, quite logically, to the calculus. Modern methods have been used throughout, and the treatment, in general, is not only sound but also very clear and well illustrated by worked examples. The aim of the authors has, indeed, been skilfully carried out and, as would be expected in such a book, ample exercises for practice have been supplied. Answers to these are given and a good inde [illegible] ided.

ENGLISH IN THE SCIENCE COURSE*

By HUGH LYON

Headmaster of Rugby School

THE Spens Report distinguishes three main purposes of English teaching: the first, "to enable a child to express clearly, in speech or writing, his own thoughts and to understand the clearly expressed thoughts of others"; the second, "the development of the power thus acquired to benefit the child as a social being, and to help him take his place as a thinking individual and a wise citizen"; and the third, "the training in the appreciation of literature". This division provides a useful basis for discussion, though it must of course be recognized that we are often, consciously or unconsciously, aiming at more than one of these objectives simultaneously. Indeed, the consideration with a class of any vital piece of literature should call into play both clear expression and comprehension, understanding of the subject-matter and literary appreciation.

I should like at the outset to deal with the vexatious matter of overcrowded time-tables. Science is a perpetually growing and expanding study; and though this may be, educationally, a stimulating and valuable thing, it is becoming a real difficulty to the administrators. Much of the work which was once done at universities is now delegated to the secondary school. The situation is becoming serious on the medical side, and real attempts are at last being made to meet it. But unless science teachers can discard old knowledge as rapidly as new truths are discovered there seems to be no real solution to the problem. It is easy enough in most other subjects; once we have grasped the geographical truth that the earth is round, we have not added to our curriculum, since there is no serious reason why we should continue to devote lessons to explaining that it is flat. And language study and even history can select for educational purposes from a field which, however far it extends, will never be too large for them. But science demands a knowledge of the whole, since (unless I am misinformed) it does not admit of short-cuts or arbitrary selection; it is moreover a practical study, which involves long periods in laboratories and considerable sacrifice of spare time. So it is not surprising that the young scientific worker is always in danger of over-specialization.

To my mind the minimum of non-scientific work a science specialist should do in a thirty- to thirty-four-period week is between ten and twelve periods: two of scripture, two of physical education, three or four of English, and three or four of a modern language. He should also have enough spare time to follow some non-scientific hobby, music or art or something of that nature. I have called this a minimum, but it is, I fear, a minimum very seldom attained and scarcely ever exceeded.

Up to the school certificate there is a blessed compulsion laid upon us all to keep the curriculum broad, and English normally gets its fair share of attention. But where other subjects are handicapped merely by the unfamiliarity of their context (whether this be Greek characters, French verbs, algebraical symbols or chemical formulæ) English has to struggle against the much more dangerous fact that most of those who are taught it think they know all about it already. Ideally, the first object of English teaching, training in simple expression and comprehension, should have been attained before the children reach the specialist stage. But this is not so, and often the young students who start on their special science course with a first certificate of general educational proficiency tucked into their pocket are in most cases incapable of expressing themselves clearly, either orally or on paper, and liable to make complete nonsense of a closely reasoned paragraph of simple prose.

One of the smart things to say about this business of teaching expression is that every master is an English master, and that teachers of other subjects ought never to pass slovenly or badly written answers. This is admirable doctrine; but there are two difficulties. The first is that it assumes that this part of English teaching can be done by a non-specialist (yet would the science teacher trust the English teacher to teach anyone even the rudest elements of science?). The second is that when the science teacher asks questions he is concerned to get answers which are right in substance; credit is given—and rightly—for accuracy in matter of fact, and the quality of expression must be a secondary consideration. Moreover, whereas in language teaching English style comes to its own in all translation work, mathematics and science deal largely with symbols and not with words. The science master's main opportunity comes in requiring descriptions of experiments; this is admirably designed to test clear and accurate statement, since slipshod explanation defeats itself. Yet beyond correcting obvious errors and pointing out how defective expression distorts or obscures the truth, the science teacher as such can do little; he has not the time and it is not his job. Yet if he will just do this he is assisting the English teacher more than h realizes; for he has helped to break through th water-tight compartments between one school 'sub ject' and another, and taught his pupil (who alway pays more attention to his specialist teacher than t any other) that good English is a means to somethin beyond itself.

The main fact remains, however, that the English master can neither assume that his pupils have bee taught to express themselves and understand any thing beyond the simplest books in their earlier year nor delegate this part of his duty to the scienc department, though he will hope for its co-operatio He must do the work himself. How then will h do it?

Partly, I think, by direct and formal instructio in syntax, grammar, punctuation and style; the are several ingenious books available which mak these things palatable, and the teacher should quick to seize any opportunity of using an odd fiv minutes in some such exercise. Indirectly, too, i the correction of essays or answer papers, he will ha chances of directing attention to the pupil's besetti sins and suggesting remedies. These sins are of var ing degrees of seriousness, and in some cases betr secrets of deeper disorder. Bad spelling may be car lessness or lack of observation or an eradicable a sometimes inherited disease; but there is nothi inherently vicious in it. Mistakes of grammar a syntax indicate a misspent youth and a sloven habit of speech. A clumsy style suggests a lack æsthetic sensibility and a lumbering mind. But no of these are so depraved as the commoner failing bad punctuation, which is the sure reflection of i accurate and slipshod thought. Commas and sen colons are as much part of the expression of an idea as the words in which it is embodied. They are not (as often seems the case) condiments to be sprinkled freely over the completed paragraph.

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* Substance of the presidential address at the annual meeting of the Science Mast [illegible] lation held at Rugby School during April 8–11.

Oral expression should not be forgotten, though there is all too little time for it.

Hand-in-hand with expression goes comprehension. Boys learn to read very many years before they learn to understand, and considerable practice is needed before they can be relied on to extract the meaning from any but the simplest passages. Many of them cannot follow a set of instructions or the steps of a straightforward argument, so it is not surprising that they show such helplessness when confronted by a fairly stiff passage of Shakespeare or one of the more elementary official publications. Much here depends on practice, which is all the more valuable since you cannot test comprehension without giving training in expression as well. All good first school examinations include a précis, but this useful exercise tends to drop out of the curriculum later. Yet there is nothing like it for testing three most important things: first, the ability to realize what the writer means; secondly, the power to distinguish between the essentials and non-essentials in the matter presented; and finally, the art of expressing the gist of it in clear, simple prose.

The second and more important stage of English instruction is "the development of this power [of comprehension and expression] to benefit the child as a social being, and to help him take his place as a thinking individual and a wise citizen". The distinction between this and the previous stage is one of emphasis rather than of method or subject-matter. From the beginning there must be some care taken in the choice of the material for the English lesson; comprehension and expression cannot proceed *in vacuo*. But as the boy gets older we should be free to consider more and more not only how he expresses his thought but what his thought is like and how it is developing and expanding; and at the same time we should be demanding of him a deeper comprehension and a critical examination of the thoughts of others.

There will of course be scope for his thought and his critical power in his specialist work, but now that psychologists have more or less agreed that there is considerably less transfer of training than was once supposed, we cannot assume that an understanding of grammatical or biological variations will show itself in a clear grasp of political or moral distinctions. It is notorious that many men of outstanding ability in their own field have gone sadly astray when they have moved out of it. The same failure to transfer ability from one subject to another is found in all spheres of knowledge, and we must therefore not imagine that when we have taught a boy to make accurate deductions or detect fallacies in his own subject he will be able to do so in all. Still less, of course, can we introduce him to the material of other branches of study by means of his own special subject. It is here that English, which is for us the connecting medium between all our diverse little worlds, comes into its own.

We have already demanded ability to express and to understand simple ideas; we might go on to say that an educated man should have achieved some general philosophy of life and have accumulated some information about the world in which he lives. He should know roughly how it is arranged spatially and the broad outlines of the experiences it has gone through in the past two thousand years. He should be able to think politically, and have some convictions on questions of ethics and community life. Most of us would of course go much further than this, but here at any rate is a minimum for our consideration. How far in our English course are we helping boys to achieve the end desired?

The first necessity is to arouse their interest, which can be amazingly hard to do. The more absorbing a subject, the more it tends to fill the horizon; and the more frequent and searching the examinations, the less time there is for the cramped student to stretch his arms and grow to his full stature. "Born a man and died a grocer"; that is the epitaph of all those whose one aim in life is to go on knowing more and more about less and less. My experience as one of the board of interviewers for county major scholarships has revealed some rather dark corners of the educational field. Some of the candidates who have come before us, not infrequently those who are the most brilliant in their own subject, have never lifted up their heads to sniff the breeze and see the stars. They prate happily to us of the laborious progress they are making towards their next examination, confess at times to a mild fondness for the pictures or a penchant for draughts; at times they bicycle for exercise and are occasionally known to dig up weeds. But their world is sealed and they are comfortably at ease within it. The War has now, in its third year, battered a little rudely at their peace, but that after all is an interruption which in time will pass. But as for politics in the deeper sense, philosophy, mountain-climbing, music, literature, long walks in moonlight, bathes in sunlit streams, social problems, art, the blessed frenzy of argument, passion, adventure, God Himself—try them where you will and the bland, blank smile of polite boredom is your only answer.

This is of course a caricature, but like all caricatures it suggests a truth; and with all deference I must go on to say that almost all those candidates to whom it applied were specialists in science. It is not that science is in itself a narrowing study; but it demands so much time, and the standard required for success in examinations is so high, that literary, political, ethical, historical, philosophical and cultural interests all have to give way.

If we are to interest boys and girls in subjects to one side of their main line of advance, we must show them how necessary it is for them to explore the roads which lead to them. We must ask questions of them, questions which seem to them (as well as to us) to be important, questions to which they are anxious to know the answers. The mere unloading of information is of itself unappetizing, unless it either is immediately relevant to their particular subject, or comes in response to a demand. It follows that we should probe them a little, try to find by judicious inquiry where their imaginations are not dead but merely sleeping. If they have learnt at all to read (and courses of silent reading lower in the school should help towards this) we can discover which way their minds have been moving by letting them write an essay on any subject (other than science) under the sun. This for a start; it may give us a line of approach. Class debates and informal discussions will test them further; once their interest is on the move it should be kept spinning by any and every means, by provocation, by challenge, by illustration, by trenchant criticism, by genuine sympathy. But if the teacher, from his eminence, thinks fit to be superior or sarcastic or condescending—then small wonder if our young scientist returns gladly to his laboratory, thinking with savage glee as he completes his analysis how hopelessly lost his English master would be inside those sacred walls.

All this does scant justice to those few young scientific boys who have been among my own keenest and best-informed English pupils in the past few years. But it must be confessed they were the exception, and that both in quantity and quality the essays on political or general subjects shown up to me by my Science VIth have compared badly with those from the Classical or Modern sides. There are three stages through which young writers normally pass: that in which their essays are too short, because they have little to say; that in which they are too long because they cannot control their material; and that (reached only by the few) in which they have suited their length to their subject, having learnt to select and arrange both their thoughts and their words. Too often I find that, while I have to wade through vast compositions by young historians and modern linguists who have reached the stage of verbosity and cannot emerge from it, the comparative brevity of their scientific brethren is due more often to their having failed to pass out of stage one than to their having graduated into stage three.

Training in the appreciation of literature is a chancy business; it depends more than almost any other co-operative activity upon the nature of the two parties to the operation and upon the *rapport* between them. But if the pupil is to make our great heritage of literature his own he must both be sensitive himself and sit—at some stage in his career—at the feet of one of the chosen votaries of Apollo. All too often he enters upon his specialist course in none too congenial a mood. He may well have suffered under the meticulous dissection of a play of Shakespeare and the minor poems of Milton by a teacher whose horizon was bounded by contexts and classical allusions and the percentage required for a credit. In this teaching the teacher must be sincere, both in judgment and in enthusiasm. The teacher must also be sincere in criticism, such as frank recognition of Shakespeare's ludicrous failures as well as his triumphs. Such teachers win respect, and respect for them is half-way to interest in their enthusiasms. The second suggestion I would make is that here as in the earlier stage much can be done by asking questions which excite a desire to know the answer.

It is not for everyone to find in literature their chief delight. But we shall do our pupils wrong if we do not endeavour to reveal to them all what abiding happiness can be found in the company of great writers. This is after all the crowning achievement of the English teacher. To ensure moderately clear expression is much, and the first step to creating an intelligent electorate. To awaken interest in social, political and moral questions, this is more, and an enrichment of the life of man. But to open the doors of the imagination, this is best of all. For we are all of us, scientist and humanist alike, citizens of two worlds; and nothing that happens in this unhappy, tortured planet where man is at enmity with man can altogether overwhelm one who has heard the lute of Orpheus, or thrilled to the passion of Romeo, or looked with startled eyes through Keats's casements upon the foam of perilous seas.

THE SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING AT RUGBY

THE first full annual meeting the Science Masters' Association has been able to arrange since the outbreak of war was held at Rugby School during April 8–10, under the presidency of Mr. Hugh Lyon, headmaster of the School. The success of the meeting justified the venture; more than two hundred members were resident in school Houses, and many others made daily visits. The lectures were stimulating, discussions fruitful even when they developed unexpected trends, visits of particular interest, and the members' exhibition as good as any of its predecessors.

A liberal education draws its energy from many sources. It is a narrow kind of humane education which neglects the study of natural science; but it is a sterile form of scientific training which takes little regard of human relationships. The presidential address on "English in the Science Course" (see p. 454) and the biennial Science and Citizenship Lecture on "Biological Instruction and Training for Citizenship" given by Prof. Lancelot Hogben left the mind open to the wider views of life.

Biology and Citizenship

Prof. Hogben aimed high. He endeavoured to approach the great national and political problems caused by the impact of science on society. At the start of his lecture he cleared the air for what followed by examining the ideal of knowledge for its own sake.

Knowledge for its own sake presumably means knowledge for the sake of the individual, the pursuit of knowledge for the satisfaction of personal curiosity; and it goes without saying that individual curiosity is a necessary condition for the growth of knowledge. To that extent knowledge for its own sake is a formula which directs attention to a legitimate aspiration and to a sound educational principle. Most of us, including those alert to social agencies which provide scope for personal curiosity, would readily concede that personal interest in a particular line of inquiry or instruction depends on circumstances which do not necessarily or commonly have a close connexion with its social usefulness. Few of us imagine that precocious concern for the remediable evils of malnutrition determines the choice of a career in biochemistry. What we do assert is that a society more alert to the problems of malnutrition would furnish more ample opportunities for biochemical research and instruction. We find it difficult to understand why biochemistry should suffer from the efforts of those who wish to promote greater public esteem for the work which biochemists carry out; and we are not convinced that a person who professes supercilious indifference towards the welfare of his fellow-citizens is on that account a better biochemist.

If they mean anything at all, this seems to be what people suggest when they make knowledge for its own sake a battle cry in the discussion of science teaching in relation to citizenship. There is nothing particularly scientific about the egocentric attitude which refuses to recognize social relations as data relevant to personal conduct. That we are members of a social group is an inescapable fact. To what extent we get opportunities and encouragement to pursue our own interests depends on whether the pursuit of our interests harmonizes with the interests of others. In a democratic society this depends partly on whether we can convince our fellow-citizens that the pursuit of our own interests will benefit them. To conceal these simple considerations behind fine phrases such as 'knowledge for its own sake' merely shows lack of imagination and common sense. If personal curiosity is the only justification for the study of biology, there are no sufficient reasons for promoting its study as a school subject. Biology can justify its claim to a place in universal instruction if, and only if, it can establish its credentials as a branch of humane scholarship, that is to say, as an essential part of the intellectual equipment of the individual for the responsibilities of citizenship. This presupposes a common basis of agreement concerning civic obligations and privileges.

As a definition sufficient for the purpose of constructive discussion Prof. Hogben suggested the following. Those of us who subscribe to the democratic process believe in promoting social adjustment by rational assent of those concerned. Specialists need educating to a rational appreciation of the social value of professional work they perform. During the past twenty years the Fascist and Nazi regimes have systematically reorganized education to promote and consolidate totalitarian values and institutions. During the same period can any single country claim to have an educational system designed with equal singleness of purpose to encourage the survival of democracy ? The pioneers of British democracy did have definite views about the type of education which democratic government calls for ; but the curriculum of our educational institutions has not kept in step with the changing functions of democratic government. What views about education for government are widely prevalent in influential circles are a 'hang-over' from a period when the functions of democratic government were very different from what they are to-day.

To a large extent the change is due to the impact of scientific discovery on human society. If the functions of democratic government were still as when Milton claimed the right to know, to utter and to argue freely according to conscience, they would be equally important assets to-day. They are not. Our outlook is necessarily different from that of Milton's contemporaries. Meanwhile, we have patched up an educational system which served the needs of democracy well enough in the eighteenth century by making provision for the training of specialists for industry. There has been no radical change of the practice of education for government. What units of government are most suitable to changing conditions, and what new tasks Government can undertake in the interests of citizens increasingly become technical issues for which historical erudition supplies no precedent. Intelligent social decision depends on understanding what technical possibilities are realizable.

The fact that scientific knowledge can discipline human beings to cease striving for what they cannot have is not the only way in which it affects social values. Diffusion of scientific knowledge has a more positive role. To say that public health is now one of the major preoccupations of Government is to say that scientific discovery, and diffusion of knowledge by its implications, have enlarged the scope of human co-operation by enlisting us in a common struggle. Out of this new awareness of common dangers is coming to birth a new social phenomenon, the rational recognition of common needs which transcend our conflicting wants. We are learning to discuss whether people have the vitamins they need and to ensure that they get them. To the extent that we do so, the virus of scientific rationality is infecting politics.

The demand for biological teaching in the school is a new thing, and there is a widespread sentiment in favour of providing biological instruction of a sort suitable to the needs of pupils not destined to become professional biologists. There is much to be said for the provision of a more flexible curriculum in the universities and for the introduction of a general science degree for teachers ; but the administrative difficulties are great, while too many professors approach the issue with more concern for departmental prestige than for the civic value of what they can contribute. Biological instruction which can justify its claim to a place in a curriculum designed to promote intelligent citizenship must give prominence to aspects of biology which are most relevant to human needs. A comprehensive treatment of the field would emphasize the following themes :

(*a*) Animal parasitology, mycology and insect pests, that is, pests and parasites of man and of domestic animals or cultivated plants.

(*b*) Genetics in relation to plant and animal breeding.

(*c*) Bacteriology, serology and chemotherapeutics.

(*d*) Soil conditions and plant nutrition.

(*e*) Animal nutrition in relation to animal husbandry ; human nutrition, respiration and excretion *vis-à-vis* occupational diseases, and animal husbandry.

(*f*) Physiology of reproduction.

(*g*) Interpretation of vital statistics.

Prof. Hogben then dealt in detail with the broad background required, and the framework of specialized studies to be erected on it.

Biology as a Social Science

The lecture by Prof. Lancelot Hogben lent strong support to the main points raised by Mr. L. J. F. Brimble during the previous afternoon, when in a lecture entitled "Biology as a Social Science" he not only pleaded for a more definite realization in schools of the sociological implications of biology but also dealt with the practical ways in which teachers could put these to effect. At this lecture Mr. H. P. Ramage (Gresham's School) was in the chair.

There is a widespread feeling that the study of man should have a larger share in all general biology courses. This has, however, been wrongly interpreted by some. For example, certain biologists, especially in the universities, have expressed the fear that this might lead to man being used as a biological 'type'. Mr. Brimble dissociated himself from this view. In any event he gave reasons which he amplified later for considering man as an undesirable type in biological teaching because in certain fundamentals he is the exception rather than the rule. Another reason for emphasizing the sociological impact of biology is the strong movement which is now taking place in favour of the development of the social sciences, both in research and in education.

Mr. Brimble expressed his concern over the tendency of many teachers to make their science teaching too heuristic, in that they lean too much towards teaching science in the spirit of research and discovery. This may be all right in the universities but in the schools it leads to the students missing other aspects of their studies which are of equal importance. There is considerable danger involved in pressing for more practical work in schools. It is true that practical work well taught is of inestimable value, but it runs the risk of becoming biased in favour of the potential scientists. Practical work cannot, of course, be abandoned altogether since it is essential in order to drive home basic scientific facts and to satisfy the fundamental instincts of the pupil. To inculcate in the average schoolchild the spirit of discovery is, of course, very desirable, but by far the majority have no intention of taking up science as a profession in later life and many of them in any event have no leaning that way, yet those young students can derive as much benefit from a properly organized course of school science as any student who proposes entering the university as a science student. It is difficult to say what cultural benefit any boy or girl can derive in later life from an empirical knowledge of the analytical tables or of the structural formula for soap. On the other hand a knowledge of the everyday applications of chemical analysis can have certain cultural repercussions.

In biology as in any other science one must realize that though there is a minority who intend following careers which demand some detailed knowledge of biological science or medicine, and although these must receive consideration for the sake of the advancement of science, on the other hand much more consideration must be given to the fuller education of all students including the potential science specialists, in which historical background, the philosophy of science and the impact of science upon society have a full share of consideration.

One important factor, however, must be taken into consideration in all stages of the student's school life, and that is the time factor. Teaching hours are comparatively short—about thirty hours a week. If the ideal educational syllabus is to be achieved, however, one must decide what shall be taught and how much of what, and in coming to this decision the dead wood must be cut out and new shoots encouraged. This applies not only to the subjects themselves but also to the content of each individual subject, as emphasized also by Mr. Lyon. In other words, a more balanced curriculum is desirable and this must be periodically revised. In spite of the time factor, if it can be agreed that any subject, no matter what it is, shall be taught in schools, then time should be found for it, and in Mr. Brimble's opinion biology, which after all is the science of life, should be taught in all schools.

Mr. Brimble also discussed the dominating and destructive effect of the examination syllabuses as they are at present constituted. The attitude of many biologists and educationists towards biology teaching in schools leaves much to be desired. Their attitude can be ascribed to at least two things, namely, the lack of knowledge of the principles and importance of biology by those educationists, sociologists and even politicians who have had no training in the subject and also the attitude of a number of authoritative academic biologists themselves. This is evidenced to-day by the remark one is too often hearing that there is not much use for biologists as such in the war effort. How far this is true can be gauged from the successful formation and activity of the Biology War Committee (see Nature of Feb. 28, pp. 227 and 234). If biology can be utilized in this way in war-time, how useful then could it prove itself, given the chance in peace-time. Biology is not just botany plus zoology; it is the science of life, and if it is going to win the place in the educational system of the country which it deserves then it must be treated as such.

Mr. Brimble then gave one or two examples in more detail of how present-day biological teaching could be so modified as to make the science more interesting and useful and to bring it to bear more directly on the study of man and mankind. He did not plead for a complete reorganization of the syllabus, since the most important factor is the frame of mind of the teacher himself. The biology syllabus even if it remains unchanged is seething with opportunities for dealing with sociological implications.

Experimental work can also utilize man as a subject. There is a tendency towards this to-day but it could be taken much further with advantage. At the same time it would be dangerous to centre the biology syllabus completely around man himself because in a considerable number of aspects he is the exception rather than the rule. For example, the conception of the survival of the fittest would be very difficult to teach if man were the main centre of interest. The question of reproduction raises several important issues which must be faced by the teacher. There seems to be little doubt that human reproduction should be given its logical place in the biology syllabus but teachers must realize that it is a delicate subject and one which must be dealt with very carefully, preferably after consultation with parents. Mr. Brimble expressed the view that it would be better that the subject be omitted than dealt with clumsily.

Principles of social biology confront us at every turn in the school curriculum; for example, individual and public health, nutritional standards, housing, population movements, race and nation, problems of family life, relations and responsibilities of one person to another, social policy of the State. Make social biology an academic discipline; then it will follow that in later life our schoolchildren will give effect to it as citizens in public administration and national policy. How deeply involved social biology becomes in national policy was illustrated by Mr. Brimble in his comparison of the attitude of Fascist powers towards social biology with that of the democracies.

Dealing with the teaching of biology in the Higher School Certificate, Mr. Brimble emphasized the deplorable domination at this stage of the requirements of the universities. The same point of view was expressed by a speaker in the discussion on "Science in Post-War Schools" (see p. 459). At present Higher School Certificate biology centres around the requirements of the first M.B. examination and the university intermediate and scholarship examinations. There can be little argument in favour of this. Indeed it is in the Higher School Certificate that biology might be treated more directly as social biology, though Mr. Brimble stressed the desirability of approaching it as such throughout the school, having once based the general precepts of biology in the lower forms of secondary schools and in the junior and senior schools more on observational science—especially natural history. In the Higher School Certificate stage sociology, civics and citizenship are often taught, and the biology course could be brought into line with these subjects or perhaps even be absorbed by them. In fact, after the School Certificate stage, course of a year or probably two might well be based almost solely on cultural values. This, from the point of view of biology, was compared with remarks made by Mr. Hugh Lyon in his presidential address with reference to English.

In the discussion which followed, several valuable contributions were made, giving the general impression that the science master of to-day is anxious to emphasize more the social relations of the subjects he is teaching. Several speakers gave indications of what they were doing in their biological teaching along the lines discussed by Mr. Brimble. In the view of Mr. E. L. Walker (Caterham School), who gave several examples of his own teaching in social biology, there should be no difficulty in emphasizing the social impacts of biology. Mr. E. Lucas (Winchester College) also gave examples of his own methods and expressed the view that the social impact of biology should be brought out in the Higher School Certificate forms. Mr. Richard Palmer (lecturer in education, University of Liverpool, now seconded to the B.B.C.) made some very constructive remarks in favour of social biology and illustrated them with some excellent examples of what he and others are doing in school broadcasts. The method of teaching nutrition as practised by Mr. Palmer in school broadcasts followed closely those which Mr. Brimble would encourage; in fact Mr. Brimble used Mr. Palmer's method as an illustration of his own point of view.

Mr. Palmer and Mr. R. Weatherall (Eton College) did not agree with Mr. Brimble that man should not be treated as a central type. Mr. Bibby (Central Council for Health Education) made several valuable suggestions in favour of biology as a social science and expressed his disagreement with Mr. Lucas that social biology should be confined to the Higher School Certificate stage. Mr. Weatherall also expressed the view that Mr. Brimble's suggestions were too modest even at this stage, and considered that present-day biology teaching should be discarded in favour of social biology "from the cradle". Mr. Brimble replied that the course which he recommended teachers should adopt was probably not so modest as tactful. It is not possible in a democracy to get things done by revolution but rather by evolution, and he emphasized the fact that to put biology teaching on the basis which he and most of his audience desired depends chiefly on gradual modification of the teacher's attitude rather than wholesale discarding of the present principles and practice of teaching.

In his reply to Messrs. Palmer and Weatherall suggesting that man should be considered the central type, Mr. Brimble emphasized the pitfalls, giving the example of bacteriology. A knowledge of bacteria must come from a study of bacteria themselves and not from a study of man, otherwise there is the risk of giving the impression that bacteria only cause disease, whereas it should be remembered, of course, that there are as many useful and even essential types of bacteria as there are undesirable types. This can best be done by treating the bacterium as the type.

The general impression given by the discussion which followed Mr. Brimble's lecture was that teachers agree that biology should be treated more as a social science than it is, and that now is the time for educationists and teachers to approach the problem, since a golden opportunity is now at hand for making the subject of more comprehensive, cultural and therefore human interest.

Science in Post-War Schools

The discussion "Science in Post-War Schools" was opened by Mr. E. G. Savage, education officer to the London County Council, who was followed by Mr. S. V. Brown (Liverpool Institute). Mr. Savage foresees the danger that, at the end of the War, science in schools might be relegated to its previous position. He suggested that peace claims for science as the core of educational studies are even more exacting than those in war-time. Present curricula are conventional rather than rational, and both subjects and ways of teaching are dominated by examinations. He outlined seven aims of secondary education:

(1) Production of physical fitness and maintenance of health.

(2) Acquisition and practice of certain fundamental skills: speech, writing, calculation and capacity to think clearly;

(3) Production of qualities and development of aptitudes valuable in home life.

(4) Training for citizenship in a European democracy.

(5) Development of high ethical standards.

(6) Acquisition of knowledge and skills for proper use of leisure.

(7) Subjects as tools for probable vocations.

Mr. Savage examined the part which could be played by science teaching in all these aims.

Mr. Brown was more concerned with the work of the master. He pointed out that, of every hundred pupils who enter a secondary school, eighty-three take the School Certificate examination and sixty pass the examination. Fourteen enter for the Higher School Certificate of whom ten pass, and five, at the very most, go on to the university. He believes that what the teacher does, he does badly in the main, since he pays more attention to Higher School Certificate candidates than to the School Certificate forms; that the standard of a pass in School Certificate is too low, and that no pupil should sit for the School Certificate examination until he is at least 15½. The Higher School Certificate examination should be divorced from scholarship awards.

In the discussion which followed, many points of view were expressed. Nearly forty years ago Anatole France, an arch-apostle for Latin as the core of school-work, wrote: "Secondary education tends to strip itself more and more of that incomparable splendour which it derived from its apparent uselessness. Since such a transformation is necessary, since it corresponds to the change in customs, it is not very philosophical to lament it overmuch. Nations have an instinct for what suits them best, and the new France will doubtless find the teaching which her children need." France did not. Let us see that we do.

Atomic Structure in Chemistry

The chemistry discussion "Should an Outline of Atomic Structure be taught in the School Certificate Chemistry Course?", initiated by Mr. A. W. Wellings (Leamington College) and Dr. E. J. F. James (Winchester College), provided lively debate and stimulating discussion. It was evident that chemistry teachers are aware of the need of making the atom problem more rational, and appreciate the part to be played by chemical studies in a coherent scheme of science teaching, in giving, not the conceit of knowledge, but an intellectual humility that recognizes that all their pupils learn and do is primarily to open up fresh horizons.

Teaching of Physics

The joint discussion with the Physical Society on "The Teaching of Physics", with Prof. Allan Ferguson in the chair, was divided into two parts: (*a*) "Fundamental Laws and Definitions"; Mr. C. W. Hansel (Bedford School) tackled the problems of the concepts of mass and weight and the systems of units involved, already familiar in his papers to the Physical Society; (*b*) opening the second half of the discussion, Mr. P. Woodland (Bedford School) stressed "The Need for a Permanent Standardisation and Guidance Committee for Elementary Physics". The main objects of such a committee would be (i) to introduce such a measure of standardization of definition, statement of laws, notation and conventions as would save teachers, students and examiners much wasted effort, and (ii) to issue each year reports on the work done in physics in schools and similar institutions, and to give advice on any changes in syllabus or technique which might be helpful both to those concerned in the teaching or organization of physics and to those who employ students who have learnt physics for a vocational purpose.

Many members followed the opening speakers in both sections and some differences of opinion were evident. The constitution of such a committee proposed by Mr. Woodland and the ways of enforcing its recommendations were then examined.

Visits were paid to the British Thomson-Houston Co. and to the English Electric Co. The Members' Exhibition was one of the successes of the meeting. Such trends as could be discerned were in the greater attention given to alternating current, the production of wireless and aerodynamical apparatus for A.T.C. instruction and in the use of small-scale apparatus in chemistry. A valuable exhibition of scientific books and publications was well attended.

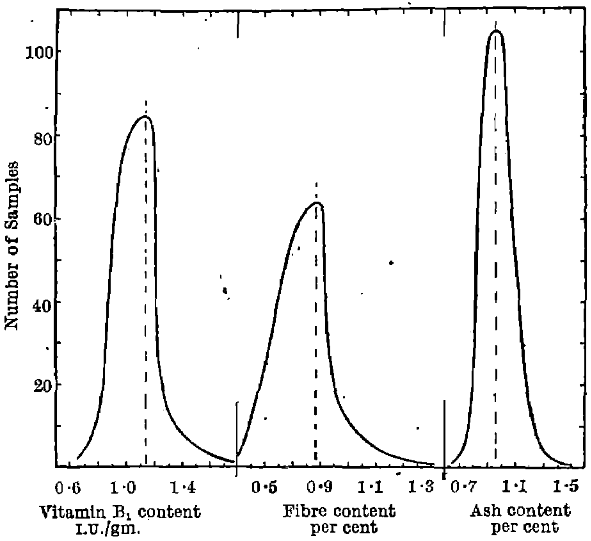
NATIONAL BREAD

By the Staff of the Research Association of British Flour-Millers

THE Medical Research Council in its second memorandum on bread[1] described in general terms the specification for 85 per cent National wheatmeal. It should contain 85 per cent of the weight of the clean wheat and in the case of a reconstituted meal should include all the white flour, all the reduction roll tails, mill finish and purifier tails and sufficient fine bran to reach the 85 per cent extraction figure. Analyses were given of meals prepared on the experimental plant in these laboratories, from which it was deduced that National meal should not contain less than 1 I.U. of vitamin B_1 per gm., and the fibre should not exceed 0·9 per cent.

The report further stated that improvers facilitate the work of the baker and lead to a more attractive loaf. Those normally used in the milling industry have been shown to have no effect on the vitamin B_1 content of flour or meal, and there is no evidence at present, on nutritional grounds, to justify their prohibition.

A few months ago the Ministry of Food arranged for a survey of the quality of the National wheatmeal being produced throughout Great Britain. Samples from more than 200 mills, large and small, were examined for vitamin B_1, fibre, ash, granularity and baking quality; in all, 303 samples have so far been examined, some of them being repeat samples from millers who had modified their methods.



Quality of Meals. The accompanying curves show the analytical results expressed as frequency curves. The modes and medians in the three curves correspond to the following figures:

	Mode	Median
Vitamin B_1	1·15 I.U./gm.	1·05 I.U./gm.
Fibre	0·85 per cent	0·70 per cent
Ash	0·95 ,,	0·95 ,,

Average figures for whole wheat are 1·3 I.U./gm., 2 per cent and 1·8 per cent respectively. The vitamin B_1 estimations were carried out by the thiochrome method[2] and could be duplicated with an accuracy of ± 5 per cent. The fibre was estimated by a method based on the Fertiliser and Feeding Stuffs Regulations 1932, with certain modifications. This method is routine in these laboratories and duplicate determinations on wheatmeals in general agree to within 0·05. The ash was determined on 5 gm. ignited in a muffle at 600° C., for six hours or overnight.

In view of the Medical Research Council's analytical criteria for wheatmeal, it is of interest to note that out of the 303 samples examined 253 had a B_1 content equal to or greater than 1 I.U. per gm. and 256 had a fibre content equal to or less than 0·9 per cent.

Quality of Breads. A meal conforming to analytical standards does not, however, always give a good loaf, and from the consumer's point of view the proper baking of National wheatmeal is just as important as its careful milling.

The absorption of each meal was determined by physical tests on doughs using special apparatus designed in these laboratories.

The moisture contents of the meals as received varied between 12·8 per cent and 16·1 per cent (5 hours at 100° C., in an electric oven):

18 per cent of the samples had moisture contents of 15 per cent or more
27 ,, ,, ,, ,, ,, ,, ,, ,, ,, 14½–15 per cent
28 ,, ,, ,, ,, ,, ,, ,, ,, ,, 14–14½ ,, ,,
27 ,, ,, ,, ,, ,, ,, ,, ,, ,, less than 14 ,,

The water absorptions varied between 14·9 and 17·8 gallons per sack.

This variation in absorption was only partly affected by the variations in moisture content, since when recalculated to a 14 per cent moisture basis it was found that:

8 per cent of the samples had absorptions of 17 gal./sack or more
32 ,, ,, ,, ,, ,, ,, ,, ,, $16\frac{1}{2}$–17 gal./sack
41 ,, ,, ,, ,, ,, ,, ,, ,, 16–$16\frac{1}{2}$,, ,,
14 ,, ,, ,, ,, ,, ,, ,, $15\frac{1}{2}$–16 ,, ,,
5 ,, ,, ,, ,, ,, ,, ,, ,, less than $15\frac{1}{2}$ gal./sack

The variations in absorption are due to differences in wheat grist, severity of milling (as affecting starch damage) and composition of meal.

Each sample was baked at its correct absorption, using 1 per cent yeast and a total fermentation time of 5 hours to the oven.

The great majority of the doughs handled satisfactorily, but the general quality of the bread was not so good. The most striking point was the number of samples with under-developed crumbs, indicating the lack of sufficient improver treatment. Wherever the size of the sample allowed, a repeat bake was made after the addition of further improver, and in almost every case the resultant bread was satisfactory, the crumb being fine-grained and smooth and the loaf better risen. It should, however, be pointed out that the samples were baked probably only a few days after milling and that their baking quality would have improved with increased age.

A few of the meals contained too much bran. In others the bran particles were too coarse: in such cases the crumb tends to be weak and friable and the bread is difficult to slice. By contrast, we have found that if the bran is too fine (of flour fineness) the loaf tends to be muddy in appearance. The loaf with the most pleasant crumb appearance has a clean background colour on which the fine bran particles are superimposed. The water content of National bread (crumb) is generally about 47 per cent, that is, about 3 per cent higher than white bread.

Some of the breads examined had weak crumbs devoid of spring. These samples had high maltose figures due probably to the inclusion in the grist of damaged English wheat from last year's harvest.

Milling and Baking National Wheatmeal

Milling. The basal objectives of the Medical Research Council specification were the maximum germ and aleurone layer and the minimum of fibre.

Precise milling technique to remove the aleurone layer cannot yet be laid down and in fact, even in the case of the factors of germ and fibre, it is difficult to formulate a general procedure. Broadly speaking, however, the *excluded* products in the milling of National wheatmeal should primarily be the scalpings of the last break, that is, the bran both large and small (including pollards), which will constitute a variable but preponderating part of the 15 per cent aimed at. The balance of the excluded 15 per cent should be filled with purifier tins (1 or 2 per cent), the small amount of aspirated stock and selected purifier tails. These latter differ widely in character, some being comparatively rich in endosperm material. Those incorporated in the 15 per cent 'reject' should be the most fibrous, and if careful visual inspection is insufficient, samples should be assayed for fibre to help in the selection.

Alternatively, the 85 per cent meal should *include*:

(1) All the white flour (say, 75 per cent).

(2) All the mill finish and reduction roll tails (say, 6–7 per cent).

(3) All the germ normally separated (say, $\frac{1}{4}$–$\frac{1}{2}$ per cent).

(4) Certain selected purifier tails (say, 2–3 per cent).

(5) If required to make up the 85 per cent, the appropriate quantity of fine bran or pollards.

Some typical figures for the composition of these factions have already been published[3].

The assumption is made here that the purification system is still run on usual lines. This is a point for further investigation, but provisionally it is felt that the continued use of the system may be found helpful in excluding as much as possible of the undesirable fibrous coatings from the meal. This will be particularly so if the feed to the break system is drier or harder than in the milling of white flour.

Experiments which will be described separately have shown that for good keeping qualities the moisture content of the finished wheatmeal should be approximately 14 per cent. Allowing a 1 per cent loss in moisture during milling, the moisture content of the mill feed should not exceed 15 per cent. This, however, is only one aspect of the problem, and further work is in progress on the more general problem, the influence of moisture content on the composition of the resulting meal. There is, however, evidence to show that with a drier mill feed there is a greater separation of aleurone layer from the bran.

It is definitely undesirable to pulverize the bran (through 10-silk), the reason being, as stated above, that the presence of bran powder gives a muddy colour to the loaf. On the other hand, coarse bran pieces (coarser than 24 w.) give a friable, unsatisfactory crumb. Between these limits we have no precise experimental evidence but are of the opinion that the smaller the bran fragments the better the loaf. The work of Macrae[4] has shown that the size of bran particle does not affect its digestibility.

With regard to germ, our experiments show that it is immaterial whether the pieces are large or small.

If the mill finish and reduction roll tails go into the meal as well as the flour, the question arises, is it worth while carrying on these reductions or could the stocks normally feeding the particular rolls go straight into the meal? To shut down these rolls would save power, wear and tear and operational demands; it would avoid some disintegration of offal. At the same time it would lead to some endosperm being present in the meal in a coarser condition than would otherwise be the case. This point also requires further investigation, but our present evidence indicates that the granularity of the endosperm is not an important factor in National bread.

Unquestionably the use of improvers is more important than with white flour, because the response of the germy and low-grade stocks to such treatment is very great. Generally the dosage should be at least 50 per cent greater than with white flour; the effect appears to be the same whether the white flour basis alone or the finished meal receives the treatment.

Breadmaking. In the past, brown bread has often been baked on very short systems using large quantities of yeast. This was feasible because of the relatively small quantities of such bread made, but now bakers will wish to make National wheatmeal bread on similar systems to those they have hitherto used for white bread.

Our experience with hand-made bread is that good quality National bread can be made on almost any system. As with white bread, the strength and soundness of the grist from which the meal is milled is a deciding factor in the quality of the bread, but in general a wheatmeal dough requires similar treatment to a white flour dough, that is, proper fermentation and correct handling. Any weakness in the grist or lack of correct fermentation or handling in the bakehouse will, however, be more apparent in wheatmeal than in white bread and, as has already been stressed, the need for correct improver treatment is particularly important.

To sum up, wheatmeal bread requires no real alteration to present-day baking methods, although for optimum quality bread greater attention to details, such as length of final proof, is desirable.

Conclusions

The survey showed that approximately 80 per cent of the mills were producing National meal conforming to the standards laid down in the Medical Research Council's specification. This survey was carried out when white flour, with its competing technical demands, was being milled.

There are a number of technical milling points which have to be investigated and explored before a meal, standard in all respects throughout Great Britain, can be produced. Equally, with greater experience of National wheatmeal, the bakers will be alive to the points requiring attention in order to produce National bread of the best quality.

It is of interest to note that the analytical criteria suggested by the Medical Research Council, namely, a vitamin B_1 content equal to or greater than 1 I.U. per gm. and a fibre content equal to or less than 0·9 per cent, apply on the commercial scale. In fact it may reasonably be expected that with appropriate modifications in the milling process, the fibre and B_1 figures will ultimately be improved still further.

[1] *Brit. Med. J.*, May 31, 1941, p. 828.

[2] Booth, R. G., *The Analyst* (in the press).

[3] Booth, R. G., Carter, R. H., Jones, C. R., and Moran, T., *Chem. and Ind.*, **60**, No. 52, 903 (1941).

[4] Macrae, T. F., Bacon, J. S. D., Hutchinson, J. C. D., and McDougall, I., *Chem. and Ind.*, **60**, No. 40, 723 (1941).

MATHEMATICAL MACHINES

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Rise of Modern Arithmetic

IN 1585, when Simon Stevin, the Dutch canal and military engineer, published his little book[1]* advocating the use of the decimal system, he opened up a new era in arithmetic. He dedicated his work "To Astronomers, Land-meaters, Gaudgers, Stereometers in generall, Money-Masters, and to all Marchants....". If he had added to this list military and mining engineers and mentioned, as he does later, that the chief use of the astronomy was in navigation, he would have given a complete list of the social conditions which were calling out for the new arithmetic. For, as Hessen[2] has shown, the sixteenth and seventeenth centuries form a period in which capitalism, and especially merchant capital, was ousting the feudal economy in Europe and setting to natural philosophers a host of new technical problems—problems which formed the source of almost all the physical sciences of that period. It was to aid this new science, as well as to help the accounting of the merchants, that the new decimal system came into being.

Stevin's system was not actually new to the world, for its equivalent had been used by the Babylonians about 2000 B.C. But the social forces that brought about its rediscovery drove mathematicians to seek even better methods of computation. Thus in 1614 John Napier[3] published his logarithms. Without these, Kepler's computations and so Newton's "Principia" would have been impossible. It was to satisfy the same needs that the first attempts to construct calculating machines were made. Such were the machines of Pascal (1642), Morland (1666), Leibniz (1694), Leupold (1727), Stanhope (1775) and Hahn (1779)[4].

These machines between them contain practically all the devices that are used in modern "general purposes" (adding, subtracting, multiplying and dividing) machines. But though these men had the genius to conceive the basic principles, none of their machines was successful. The technique necessary to cut gears of sufficient accuracy and durability did not exist; the call for calculating machines was not sufficient to cause the technique to be developed for this purpose alone, and it was not until after the Industrial Revolution in Great Britain that a greatly increased demand for calculating machines, with a demand for mechanical efficiency in many other fields, gave sufficient incentive to force the solution of these technical problems.

The Industrial Revolution

The early part of the eighteenth century was a period of quiescence in the history of science. The scientific problems arising from the needs of mercantile capital had in the main been solved and it was not until the Industrial Revolution produced a demand for power, which could not be satisfied by the then existing means, that a revival took place—chiefly in problems arising from the steam engine, leading to thermodynamics, a subject which reached a reasonable degree of perfection about 1850.

Curiously enough, English mathematics did not keep pace with these scientific advances. Newtonian mathematics, representing essentially the needs of the older mercantile capitalism, was firmly established in the universities; the newer industrial manufacturing classes and the new sciences representing their needs had not yet succeeded in gaining a foothold there. In the early nineteenth century only one English university mathematician was facing the economic changes that were taking place and the revolution in mathematics that should accompany them. That man was Charles Babbage, Lucasian professor of mathematics at Cambridge. His book, "The Economy of Machines and Manufactures" (1832), must have seemed then a strange work for an academic mathematician, containing as it did a thorough analysis of the economic and technical aspects of the new industries. In "The Decline of Science in England" (1830), too, he shows a clear realization of the way in which the established scientific bodies (including the Royal Society) were degenerating, though he does not seem to have been really conscious that this degeneracy was a result of their lack of interest in the scientific problems which he so ably discusses in the other book.

It was this man, combining the tradition and educational advantages of an academic mathematician with a realization of the new fields that science must conquer, who made the next notable attempt to produce a practicable calculating machine. His two attempts were extremely ambitious[3,9,10]. First came his "Difference Engine", intended mainly for the construction of tables, the principle of which is briefly as follows: Consider, for example, a table of squares, beginning 1, 4, 9, 16, 25, . . . The first differences (that is, the differences between each number and its predecessor) read 3, 5, 7, 9, . . .; the second differences (differences of first differences) are 2, 2, 2, . . ., in fact, constant. Once this property has been observed, the original table may be extended by noting that the next first difference is $9 + 2 = 11$, and thus the next term in the table is $25 + 11 = 36$, etc. Thus we can calculate any number of terms in the table by addition only, instead of by multiplication, and similarly for other tables.

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* References in this form are to the Bibliography at the end of the article.

Construction of the machine was begun by the Government in 1823, but the work was suspended in 1834, when £17,000 had been spent, and abandoned in 1842. The chief reason for the failure and for the enormous cost was the want of proper machine tools for the execution of the work—the necessary technique was still not developed. The modern National accounting machine[11] is essentially similar to the one Babbage planned.

Babbage's second machine, the "Analytical Engine", was even more ambitious. It was intended to tabulate by punch-card methods the values of any function for which a finite mathematical expression can be written. Although Babbage began work on this machine in 1834, the technical problems were too great and little progress was made. The modern counterpart of this "Engine" is the Hollerith punch-card machine[12].

First Successful Calculating Machines

With the possible exception of the Thomas de Colmar "Arithmometer" (1820), no successful calculating machine was produced until the 1880's, when the continually growing demand, coupled with the accurate machine tools which were now available, caused an extremely rapid development of many efficient machines. The Brunsviga, for example, first appeared in 1892, and twenty thousand had been made by 1912. The Comptometer, the first successful key-operated machine, appeared in 1887; and many other successful machines were made about the same period[3]. Since that time no fundamental change has taken place in the ordinary calculating machine, though a multitude of detailed improvements have greatly increased its speed and efficiency[5,6].

Any machine which performs the four fundamental operations of arithmetic can, of course, be used to solve any computational problem. But in many cases the process is likely to be too slow and tedious. It is for this reason that we find, again in the nineteenth century, especially the third quarter, and in the twentieth century, the appearance of large numbers of more specialized machines, each intended to solve rapidly and easily some particular type of problem the importance and frequent occurrence of which makes it worthy of this special attention.

To begin with, there are the National and the Hollerith, which have already been mentioned. The former has its chief application in the preparation of tables and has been extensively used in computing the "Nautical Almanac". The second is used, among other things, for statistical analysis and has been applied to agricultural statistics[12].

The Differential Analyser

Differential equations have formed an important part of mathematics from Newton onwards, but in the nineteenth century and especially towards its end, they became so important as to force scientific men seriously to tackle the problem of their solution. At first various instruments, "integraphs"[13] were produced for solving special types of equations, but these sink to insignificance beside Kelvin's proposal for the mechanical integration of any ordinary differential equation.

The principle of the disk-and-wheel or disk-sphere-and-cylinder integrator for evaluating $\int f(x)dx$ had been used since the early part of the century in various integraphs and planimeters. Essentially it is a continuously variable gear. If the gear ratio is $1 : f(x)$ and the input shaft turns through an angle dx, the output turns through $f(x)dx$. If now the input turns continuously representing the variable, x, while the gear ratio is connected with x in such a way as to describe $f(x)$, then the total angle through which the output shaft turns is $\int f(x)dx$. By mechanical interconnexion of such integrators, any ordinary differential equation can (in theory) be integrated. In 1876 Kelvin pointed this out in regard to linear differential equations[7].

But the mechanical difficulties were too great. The friction drive from disk to wheel does not give sufficient power to drive the further mechanical connexions that are required. Thus Kelvin was unable to produce a working model, and indeed this was not done until about 1931, when Bush solved the problem of the 'torque amplifier'[13,14]. The principle of the torque amplifier is extremely simple; it is essentially the same as the capstan of a ship. The capstan is kept rotating, a rope is wound several times round it, and it is found that a small pull on one end of the rope produces a much stronger pull on the other end. With this addition, Kelvin's ideas can be put into practice.

Importance of Wave Motion

Physics of the latter half of the nineteenth century is very much concerned with wave motion. Maxwell's electromagnetic theory is its greatest theoretical achievement, but its real basis lies in two subjects of vital economic importance, which very much occupied men's minds at the time—telegraphy and tides. The first practical trial of telegraphy took place on the London and North-Western Railway in 1837. The first successful Atlantic cable was laid in 1865, and many technical problems arose in this connexion. Thus the discussion of the nature of the wave-motion in the cable assumed the utmost importance.

Investigations of tidal phenomena date, for obvious reasons, from the earliest days of the mercantile capital period, and notable work on the problem was done by Newton, Euler and Laplace. All this work was of a synthetic nature—attempts to produce general formulæ to represent the motion of the tides. But a gradual accumulation of evidence showed that the problem was too complicated to be tackled in this way. Thus, when the British Association appointed a committee to deal with the matter, Kelvin was led to suggest (about 1876) the alternative *analytic* method, namely, to analyse the tidal curve at any one spot into its simple harmonic components, to extrapolate each of these into the future and to recombine them to give the tide at any assigned future time.

These two sets of problems lent great importance to the harmonic analysis and synthesis of wave-motion, and it was not long before many machines were produced to deal with this problem. By Fourier's theorem the problem of finding the harmonic components of a periodic function $f(x)$ is equivalent to that of performing a set of integrations $\int_0^{2\pi} f(x) \cos nx dx$, for $n = 0, 1, 2, \ldots$. In 1876 Kelvin pointed out that such integrations could be performed by an adaptation of the wheel-and-disk integrator, as described above. Many machines have been constructed on this or similar principles, the most important modification being the use of several integrators simultaneously, representing several values of n. The next few years brought many harmonic analysers; for example, those of Henrici (1894), Sharp (1894) based on the principle just outlined and of Yule (1895), Michelson and Stratton (1898), Mader (1909) and Boucherot (1913) on other principles[3].

More interesting, perhaps, is Kelvin's tide-predictor (1876)[3, 7]. In spite of its specific name, it is a machine for performing a synthesis of *any* system of harmonic components. It consists of a number of pulleys, conveniently arranged, each of which is given a harmonic motion. A wire, with one end fixed, passes over each in turn, and the other end then describes a motion which is the sum of the motions of the pulleys. Such machines are now in use in the navigation departments of several governments.

In recent times there has been a further outburst of harmonic analysers and synthesizers, such as those of Kranz (1927)[15], and Brown (1939)[16] based on the principle of the tide-predictor, and of Montgomery (1938)[17] using an optical method. The reason for this outburst seems to be the great crop of wave-motion problems arising from radio, the 'talkies' and quantum theory. Incidentally, by a simple mathematical trick, any harmonic synthesizer can be used as an analyser; it is very surprising that this does not seem to have been noticed before the 1920's.

Linear and Integral Equations

For reasons of space we can only refer briefly to two out of many other types of machines[8], though some of them are nearly as important as those described. The solution of sets of simultaneous linear equations is obviously an important problem, for example, in the theory of stresses in frameworks. Many machines have been constructed to solve such equations, for example, those of Kelvin (1878)[3,7], and Wilbur (1936)[19], working mechanically, and that of Mallock (1932)[18] on an electrical principle.

Just as differential equations describe, as it were, the point a system will reach, given only where it started and in what direction it is going, so also integral equations solve problems where the past history of a system is required to determine its present and future state. The importance of many such problems has recently grown enormously, for example, in hysteresis and in biological growth problems. Thus machines to evaluate definite integrals containing a variable parameter and so indirectly to solve integral equations are a recent development of considerable significance. They use optical methods[8, 20, 21].

Thinking in Terms of Machines

One of the reasons why mathematical machines were developed in the period after the Industrial Revolution rather than in the earlier merchant capital period was that the industrial period presented to the mathematician a much greater variety of problems which could only be solved within the given limits of space and time by the use of every available instrument. Another reason was that the Industrial Revolution had developed the necessary mechanical technique. To these must be added another reason, namely, the way in which men's minds had been altered by the circumstances in which they lived. Kelvin was in many ways the typical scientific worker of the latter nineteenth century, his activities ranging from what would now be called 'pure' research to detailed problems of applied technology and even to the application of his science as a very successful man of business, for he left a considerable fortune. Such men were used to thinking of the machine as typical of man's attack on the problem of living, and of a differential equation as representing the motion of a machine; and it was not difficult for them to reverse the process and make the machine represent and solve the equation. But to men of Newton's time a differential equation represented the motion of the moon or of a projectile, neither of which could be used conversely to solve the equation. Thus they were unlikely to think of machines as a method of dealing with their mathematical problems.

A similar ideological effect appears in the recent development of integral equations and machines for solving them. In the nineteenth century wave-motion must have seemed typical of the way of the world. It appeared in telegraphy and tides. But it also appeared as typical of history. The world seemed a more or less stable system; it had the wave-motion of the trade cycle, but it did not show obvious signs of a direction of development. But in the last two decades processes which were observed by only a few in the nineteenth century have become obvious to all. The world is changing; the old system is visibly breaking down and a new one is needed. Simple harmonic motion no longer adequately describes the world-machine, and the historical method of thinking becomes more and more necessary. It is in these circumstances that integral equations, the mathematical method of taking into account the history of a system, have so enormously developed. They arise from concrete problems, but it seems likely that the ideological background of a society in which history is so imminently visible has considerably helped their development.

Organization of Calculation

In spite of the headlong development of mathematical machines in the last seventy years, it remains unfortunately true that their vast potentialities are still largely unexplored. Many of these machines cost thousands of pounds to build. They cannot be constructed in order to solve a few problems. Yet there are many problems of such a nature that hundreds of workers all over the world meet half-a-dozen in a lifetime. At present that means to each of them many hours of laborious computing with a Brunsviga or even a slide-rule. An efficient organization with centralized laboratories to which all such problems could be sent would make it possible to provide machines to do this work in one-hundredth of the time and so would save the world many hours of valuable labour and enable the worker to spend his time more profitably than on handle-turning.

At least one attempt to provide a service in Great Britain on these lines has been established, on a business footing, and within its limitations has proved to be highly valuable. But such privately owned concerns may not be able to obtain all the more expensive and more specialized machines, which are at present mainly scattered throughout the laboratories of industrial companies, universities and similar institutions, where their use is practically restricted to members of the institution concerned. It would appear that the great possibilities of mathematical machines can be fully realized only through an organization supported by public funds, concentrating all types of machines under its care and using them to solve the problems of scientific workers wherever they may happen to be working. This must stand as not the least of the problems of social re-organization which confront the world to-day.

Future Trends

At present machine mathematics is widely regarded as being not quite respectable, not quite mathematics. This is especially the opinion of that school who see the chief justification of mathematics in what they interpret as its uselessness, combined with its "intrinsic beauty". Such mathematicians should take a warning from history. For theirs was the attitude adopted by English mathematicians of the eighteenth and three-quarters of the nineteenth century, with the result that, while Continental mathematics forged ahead, the English mathematician toyed with his "beautiful" problems of the Newtonian era, ignoring the fact that these had by then lost all relation to social usefulness and that the conditions of the Industrial Revolution were calling for new techniques. Thus it came about that Great Britain dropped far behind and had to be modernized with a jerk, when at last the scientific representative of the industrial capitalist burst into the universities, besides setting up his own research institutions.

There seems not to be a danger of this happening again. The real problems of to-day need machines, and machines have come to stay. If mathematics is to advance, it must recognize this fact and re-organize itself appropriately. This implies re-orientation in the light of the possibilities and the limitations of machines. To give one trivial example, in all machines so far in existence, the multiplication of two varying functions is an extremely awkward matter, while integration is comparatively simple. This suggests that our analysis should be 're-worded' so as to substitute integration for multiplication wherever possible. This, of course, may mean the loss of some formal elegance, but formal elegance must and will give way to the needs of practice.

Select Bibliography

Miscellaneous:

[1] Stevin, English translation by Robert Norton: "Disme: the Art of Tenths; or Decimall Arithmeticke" (1608).

[2] Hessen, B., "The Social and Economic Roots of Newton's Principia", in "Science at the Cross Roads", N.I. Bukharin *et al.* (1931).

General Surveys:

[3] "Handbook of the Napier Tercentenary Exhibition", ed. E. M. Horsburgh (1914). Contains an account of the life and work of Napier, detailed descriptions of many mathematical machines and instruments and various other matters up to 1914.

[4] Wolf, A., "A History of Science, Technology and Philosophy in the 16th and 17th Centuries" (1935), 560–63.
Wolf, A., "A History of Science, Technology and Philosophy in the 18th Century" (1938), 654–60.

[5] Comrie, L. J., "Calculating Machines", being Appendix III to L. R. Connor's "Statistics in Theory and Practice" (1938) (published separately). The best concise account of modern calculating machines.

[6] "Encyclopædia Britannica", article on calculating machines.

[7] Thomson and Tait, "Natural Philosophy" (2nd edn.), Appendix B, Gives an account of all Kelvin's machines.

[8] Bush, V., "Recent Progress in Analysing Machines", Proc. 4th International Congress of Applied Mechanics (1934). An excellent review of progress to 1934; contains descriptions of some of the machines discussed in the text and several others.

Particular Machines:

[9] Babbage, H. P., "Charles Babbage's Calculating Engines" (1889).

[10] "Encyclopædia Britannica", article on Charles Babbage.

[11] Comrie, L. J., Supplement to *J. Roy. Stat. Soc.*, **3**, 87 (1936).

[12] Comrie, L. J., *J.Roy. Stat. Soc.*, **4**, 210 (1937).

[13] Bush, V., *J. Franklin Inst.*, **212**, 447 (1931), on the first differentia analyser.

[14] Hartree, D. R., *Math. Gaz.*, **22**, 342 (1938), gives the best simple account of the differential analyser.

[15] Kranz, F. W., *J. Franklin Inst.*, **204**, 245 (1927).

[16] Brown, S. L., *J. Franklin Inst.*, **228**, 245 (1939).

[17] Montgomery, H. C., *Bell System Tech. J.*, **17** (1938).

[18] Mallock, R. R. M., *Proc. Roy. Soc.*, A, **140**, 457 (1932).

[19] Wilbur, J., *J. Franklin Inst.*, **222**, 715 (1936).

[20] Gray, T. S., *J. Franklin Inst.*, **212**, 77 (1931).

[21] Hazen, H. L., and Brown, G. S., *J. Franklin Inst.*, **230**, 183 (1940)

NEWS and VIEWS

Manuscripts of Charles Darwin

We understand that the trustees of Charles Darwin are considering disposing of original MSS. of Darwin's which are in their care. These include the manuscript journal kept by Darwin during the voyage of the *Beagle* (1831–36) on which was based his "Journal of Researches into the Natural History and Geology of the various countries visited by H.M.S. *Beagle* . . .", Darwin's autobiography in his own handwriting with alterations made or suggested by Mrs. Darwin, the manuscript of "The Effects of Cross- and Self-Fertilization in the Vegetable Kingdom", the 1844 sketch of "The Origin of Species", and a large number of letters and miscellaneous material most of which has been published. Although this material may contain little of strictly scientific value, it has an obvious interest to the historian of science as revealing the workings of Darwin's mind at different periods of his life, and it would be unfortunate if the material should be dispersed. Such documents should be preserved in a library where access to them can be had by students, and it is to be hoped that some benefactor of science, aided perhaps by the Friends of the National Libraries, or some similar body, may be able to secure them for that purpose.

Future of Radio Communication

Captain P. P. Eckersley addressed the British Institute of Radio Engineers at its meeting on April 18 on "The Future of Radio Communication". He dealt at some length with the limitation of communication channels available, for the whole of

Europe for example, without mutual interference, and explained that, although the number of possible frequencies available might be infinite, the useful range is not. He said that the service range of transmission might be said to be proportional to its wavelength, so that very high frequency transmissions have a very small reliable service area. If the band width occupied by a transmission could be reduced, the number of channels could be increased in the same proportion. Examples of narrow band transmissions cited included single sideband, suppressed carrier (for wired transmissions) and restricted modulation frequencies, and he mentioned an American invention by which an intelligible modulation range of 200–3,000 c./s. can be transformed at the transmitter to a range of from zero to a few hundred cycles a second, thus reducing the sideband frequency width to be accommodated, and providing further channels in a given range of carrier frequencies ; the signal is re-transformed at the receiver. Captain Eckersley still believes, in spite of theories to the contrary, that sidebands were real.

Dealing with wired broadcasting, Captain Eckersley expressed the view that this system would provide a solution to ether congestion, and envisaged a future when perhaps even a special cable would be laid to every house, not only in Great Britain, but also in every country of the world, linking continents as far apart as Europe and America, although he realizes the present difficulties of operating a submarine cable of such dimensions. The number of channels available in a wired system would be infinite, and in this, together with the American invention described, he sees in the future a solution of our broadcasting problems.

Development of Fuel Research

On March 26 Dr. E. W. Smith, director-general of gas supply, Board of Trade, addressed the Fuel Luncheon Club of London, choosing as his subject the question : "What do we want ?" By "We" he meant the British community as a whole and not the interests of some particular industry or individual. He suggested that fuel, heat and power supply is more important than any other future concern of the Government, even than agriculture. Unrestricted competition, he said, should be abolished. The utilization of coal has led to our growth of industry and population, but the advantages so gained cannot continue indefinitely, and possibly not for long. To raise coal and sell it abroad at a loss is folly. To do the same with competitive fuels at home is equally foolish.

The Board of Trade has brought into one control coal, gas, electricity and oil, but if a Ministry of Fuel were established it should do more than regulate these. It should be a highly competent body, independent of vested interests, capable of advising, with long views, on the whole fuel policy of the nation. Fuel is becoming dearer and the mere stimulation of coal consumption is wrong. Allocation of fuel for domestic and industrial use should be made according to what has been determined as the best for a given purpose. This calls for a development of research on a great scale, greater than any hitherto known in Great Britain. Fuel research should no longer be distributed among many competitive research organizations, but co-ordinated in one comprehensive scheme with directors of the specialized branches. It should then be done with the most ample and best-equipped facilities for experiment.

Statistical Theory of Accident Proneness

The scientific investigation of industrial accidents may be regarded as commencing in 1919 with the publication of a report by Prof. Major Greenwood and H. M. Woods for the Industrial Health Research Board, then known as the Industrial Fatigue Research Board, the data in which indicated that the hypothesis that persons were different in their liability to accidents from the start gave the best fit to the observed distributions. The mathematical considerations underlying these theoretical distributions were examined by Prof. Greenwood and Mr. Udny Yule in a paper published in the *Journal of the Royal Statistical Society* in 1920. A further paper on theory and observation in the investigation of accident causation by E. G. Chambers and G. Udny Yule has now appeared in the supplement to the same *Journal* (7, 89–109 ; 1941). In this, Mr. Yule gives a note on the statistical theory of accidents with special reference to the time factor, application of which to accident data leads to the conclusion that a lengthy period of experience is necessary for an individual proneness to accidents to manifest itself fully. Accident proneness may be regarded as a latent disposition needing certain circumstances to reveal it, rather than as an active function which is constantly in operation. Individual differences in accident proneness may, therefore, play their part chiefly in the earlier period of exposure to risk, their importance diminishing as the period of exposure increases. The maximum benefit gained by selective tests for proneness is, therefore, likely to accrue when the tests are applied to new entrants into risky occupations. The chief contributors towards accident rate might thus be found and eliminated during their most vulnerable periods. This conclusion is supported by the observed fact that selective tests are of much less value when applied to experienced workers than they are when given to new entrants.

To the discussion on this paper Dr. J. L. Irwin contributed an analysis of variance leading also to the conclusion that the most likely explanation of the differences between drivers is a difference in individual proneness to accidents, and Prof. Greenwood, commenting on the fact that Mr. Chambers had shown that a necessary condition for accepting the proneness hypothesis as a complete explanation of the fact is not fulfilled, agreed with his suggested explanation that the rate changes with time and pointed out that the study of Royal Air Force accidents might be of value here, since the high standard of selection probably eliminated the pathologically prone.

Fluorescent Light Sources

In a paper before the Illuminating Engineering Society on April 14, Mr. J. N. Aldington pointed out that two types of fluorescent lamp have been developed within the last decade, both of which employ the mercury vapour discharge as the source of primary radiation. In the first type, envisaged so long ago as 1900 by P. Cooper Hewitt, a high-pressure mercury arc operates with a high luminous efficiency, and fluorescent coatings on the outer bulb containing the arc tube produce colour modulation of the emitted light. Ultra-violet and violet radiation of a wavelength above about 3,000 A. is absorbed by suitable inorganic sulphides and is re-emitted in the visible region to supplement the dominant mercury light. The change in overall efficiency brought about by this energy transformation is negligible, but the effect on the colour-rendering properties of the emitted light is appreciable and useful. The second type of fluorescent light source is exemplified in the 80 watt MCF/U lamp, which was put on the market in March 1940, and is being used extensively for industrial lighting. A fluorescent powder layer coated on the inside surface of the tube containing a low-pressure mercury discharge tube is so vigorously excited by the resonance radiation from mercury that it produces about ten times the light given by an uncoated tube of similar size. The light is white and has colour-rendering properties sufficiently close to those of daylight for most industrial applications. The fluorescent layer is a mixture of inorganic powders which if used separately would give blue, yellow and red light and they are most efficiently activated by radiation of wave-length 2,537 A.

As the 80-watt lamp was designed primarily for industrial lighting to meet the demands of war-time conditions, the major applications in Great Britain have been in industry. Much experience has, however, been gained in the United States, where in the last three years fluorescent lamps have been introduced into practically every lighting field. It is found that the low surface brightness of approximately 0·5 candle per sq. cm. in the case of the 80-watt lamp and the large size of the source render it of great value for producing illumination conditions which can be made to approach daylight interior lighting. Shadows are softened and in a well-designed installation the illumination of vertical planes can be made effectively. In most cases stroboscopic effects are of little importance, the phosphorescence of certain of the powders used in the lamp construction assisting in bridging the gap between the cyclic changes in light output. The psychological effect of apparently cool light has proved advantageous in certain industries, and the freedom from glare in a well-designed installation is a noteworthy feature.

A Projected Canal System for England

In a booklet entitled "The Projected Grand Contour Canal" (Birmingham: Cotterell and Co., 2*s*.), Mr. J. F. Pownall describes his ideas of a waterway linking together the main ports of England and accessible to coasting vessels up to 1,500 tons displacement, as well as canal barges. He points out that in the main watersheds of England, the lowest cols are at approximately 300 ft. As a result, he plans this canal to follow as near as possible the 310 ft. contour, which would obviate canal locks, with their delay and cost of upkeep, and necessitate only a few tunnels. Already some two hundred miles of existing canals lie at about 300 ft.; others are at lower levels. These might be linked by lifts, which have the advantage over locks in that they do not lose water in operation.

The main canal and its chief branches would be 864 miles long and would be 100 ft. wide at the water level, 17 ft. deep, with a clear headway under bridges of 80 ft. From London the Lea navigation would be used and improved as far as Hertford, where the new canal would begin with a lift. Thence it would pass through Bletchley, Rugby, Lichfield and Market Drayton to Manchester, with branches to Birmingham, the Trent and Wrexham. Through Lancashire it would pass by Clitheroe and Skipton, with a branch to Bradford and the Aire and Calder navigation, and thence along the eastern flank of the Pennines to Richmond and Newcastle, with a branch to Hartlepool. In the south, branches would reach Bristol and Southampton. At or near all the great ports, lifts would operate to and from the 310 ft. level. Sixty per cent of industrial England would thus be served at a cost which Mr. Pownall estimates at a halfpenny per ton mile. Other features of the suggested canal would be its service as a 'water grid' and as a line for gas, oil and other pipes which could be laid on its bed.

Wood Pigeon Nest Census

An ecological survey of the wood pigeon's breeding habitats in Great Britain is being organized by the Edward Grey Institute, Museum Road, Oxford, as part of the British Trust for Ornithology's investigation into the biology of this species. The basis of the survey is a punch card, one being used for each occupied nest. The card is printed with a simple system of habitat classification; types of wood are illustrated by stating the name of the chief tree, shrub and flower. The finder also gives details of the position and contents of the nest, completing the hatching and fledging records if there are opportunities of returning to the nest. A punch card may be used at any time when a nest is found, but the maximum information is obtained from a census of any area of known acreage. If possible the census is repeated each month, cards being made out for nests not previously discovered and fresh information added to the old ones. The scheme is therefore flexible, allowing contributions from either an individual with only a few minutes to spare, or from members of a team; it also allows scope for organization within the team, encouraging those with specialized knowledge, such as a botanist, photographer, 'surveyor', and so on. For those proposing to organize a team census a pamphlet "How to Organise a Wood Pigeon Nest Census" is available from the Institute.

As the most active members of the Trust are now serving with the Forces a special appeal is being made to schools and youth organizations to help with the census. Several biology teachers are now using pigeons in dissection classes, and are studying crop contents, checking their identifications with observations in the field. A leaflet "Directions for Biologists" is available for anyone willing to undertake the examination of pigeons.

Lodgewood Telegraph Poles

C. H. Amadon, in an article on this subject (*Bell Lab. Rec.*, 20, No. 6, Feb., 1942), refers first to initial experiments made to preserve pine poles by creosoting, and secondly describes the method finally adopted. In the latter the poles are placed in closed cylinders and compressed air is admitted for about half an hour until the pressure rises to about 85 lb. per sq. in. Some of this air enters the cells of the wood. Hot creosote is then pumped in until the cylinder is full, pressure being maintained at 85 lb. per sq. in. during this period. More hot creosote is next pumped in until the pressure rises to about 135 lb. per sq. in. During this period of nearly three hours the creosote is taken up by the wood and fills its cells. At the end of this pumping period, air pressure is released and a vacuum is created under which the entrapped air brings to the surface most of the excess creosote, which drips off and is pumped out of the cylinder. The vacuum is broken after about an hour and live steam at a pressure of 20 lb. per sq. in. and a temperature of 260° F. is admitted to the cylinders and maintained for three hours to re-establish pressure in the wood and increase the fluidity of the remaining creosote. A vacuum is then drawn again and held for an hour, during which time more of the creosote comes to the surface and drips off. The vacuum is then broken and the cylinders are opened. Any liquid creosote on the surface of the poles is quickly reabsorbed, and the poles are reasonably clean. The first charge treated in this way completely satisfied all requirements. Approximately 50,000 full-length pressure-creosoted lodgepole pine poles have been treated according to the process described, with a high degree of conformity to the desired results in terms of penetration, consumption of creosote and cleanliness of the poles.

X-Ray Reflexion and Scattering with Frequency Change

Theory and experimental work on the quantum reflexion and quantum scattering of X-rays are dealt with by Sir C. V. Raman in two papers (*Proc. Roy. Soc.*, A, 179, 289 ; 1942). The quantum or modified scattering is due to the excitation of the elastic solid or low-frequency vibrations of the crystal lattice by the X-ray photon. It has a very low specific intensity proportional to N (the number of lattice cells) and is distributed over a wide range of solid angles. The quantum or modified reflexion is due to the excitation of the infra-red or characteristic high-frequency vibrations of the crystal lattice by the X-ray photons. Its intensity, like that of the classical or unmodified reflexions, is of the order N^2, though usually smaller in absolute value than the intensity of the classical reflexions. The frequency changes which play a fundamental part in the theory of both phenomena appear as necessary consequences of both the classical and quantum theoretical points of view, but the law of intensity variation with temperature is quite different in the classical and quantum formulations. Experimental studies at low temperatures are specially important for the differences between the two theories. The influence of the modified X-ray reflexions on the intensity of the classical reflexions and their variation with temperature are discussed and shown to be of even greater importance then the effect on the same of the X-ray scattering by the elastic solid vibrations. In the second paper experimental results on diamond are reported agreeing with the theory.

An Improved Capacitance Bridge for Precision Measurements

To meet the demand for increased precision a new standardizing capacitance bridge, known as the No. 12 type, has recently been developed by the Bell Telephone Laboratories and is now described by W. D. Voelker (*Bell Lab. Rec.*, 20, No. 5 ; 1942). This bridge, operating at frequencies up to 200 kc., has a range of from 0 to 1·11 μF., and from 0 to 1000 μmhos. It is of the equal-ratio-arm type, the arms being of woven-wire resistance. A slide wire at the junction of the two resistances and an air condenser that allows capacitance to be shifted from one arm to the other, permit a small amount of adjustment that may be required at infrequent intervals to offset the effects of ageing. The resistances form the adjacent ratio arms of the bridge, and permit an unknown capacitance in a third arm to be measured against an adjustable standard capacitance in the fourth. This is the basic principle of the bridge. Conductance standards are included in the bridge. For measuring the larger values of capacitance silvered-mica condensers are employed as standards, while for smaller values of capacitance, air condensers are more convenient. The air-condenser standard consists of three decades of fixed capacitance and a movable plate condenser for fine adjustment. The control dial is calibrated to indicate directly the capacitance of the unknown for each position of the dial.

Medical Services in Sweden

The March issue of the *Anglo-Swedish Review* gives an interesting account by Torsten Trietz of the organization of medical services in Sweden. Preventive medicine is administered by public health officers, of whom there is one in each of the twenty-four counties and larger cities. Outdoor medical treatment is provided by the following groups of physicians : (1) in the provinces the district doctor is a State official appointed for the medical care of the population in rural districts, who receives a fixed salary and retiring allowance ; (2) urban physicians, who are also salaried physicians but are paid by the municipality ; (3) private practitioners who are also paid a salary. Owing to their social importance tuberculosis and venereal diseases are compulsorily notifiable and free treatment is provided. There is a panel service national health insurance, of which the cost is borne partly by the State and partly by the fees of the insured. The public indoor service is mainly provided in general hospitals and is administered by the county councils or municipal councils, and paid for by the taxpayers. The hospital treatment of tuberculosis is organized in sanatoria, of which there are about 100 with about 8,000 beds. Care of infectious diseases in fever hospitals is compulsory for certain diseases and is free. Radiological treatment of malignant growths and similar diseases is organized in special cancer clinics at Stockholm, Gothenburg, Lund and Uppsala. All indoor relief of mental cases is administered by the State in some twenty hospitals containing 17,000 beds. The nurses in Sweden receive three years training in the larger hospitals in co-operation with the Swedish Red Cross. Midwives are trained at two colleges, and treat the vast majority of cases of childbirth.

Courses of the Lower Ganges

The November issue of *Science and Culture*, which is conducted by the Indian Science News Association with the aim of advocating the application of scientific knowledge to the national welfare of India, contains an interesting article on the antiquity of the Lower Ganges and its courses. Mr. N. K. Bhattasali approaches the subject from the historical point of view. Little that is very definite emerges from Mahabharata and Pauranic literature, though a certain amount of evidence as regards the various mouths of the river suggests relatively few major changes. Ptolemy in A.D. 150 gave a full account of the Lower Ganges, and Mr. Bhattasali finds that, allowing the necessary corrections for Ptolemy's longitudes, the five mouths of the river are in approximately the same longitudes to-day as about nineteen hundred years ago. There are several maps in the article, including Rennell's map of 1761 and van den Broucke's of 1660.

Agricultural Scholarships

THE Ministry of Agriculture and Fisheries is offering for award, under its scheme of scholarships for the sons and daughters of agricultural workmen and others, a limited number of agricultural scholarships. The scheme was suspended following the outbreak of war but has been resumed this year in a modified form, and the Ministry invites applications for the following scholarships: ten senior scholarships, tenable at agricultural colleges or university departments of agriculture, for diploma or degree courses in an agricultural subject or at veterinary colleges for courses in veterinary science; thirty junior scholarships, tenable at certain farm institutes or similar institutions, for courses not exceeding a year in duration, in agriculture, horticulture, dairying, or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers whose means and method of livelihood are comparable with those of agricultural workmen, and to persons who are themselves *bona fide* workers in agriculture. Further information concerning the scheme, and forms of application, may be obtained from the Secretary of the Ministry, Hotel Lindum, St. Annes, Lytham St. Annes, Lancs.

Recent Earthquakes registered at Kew

BETWEEN March 8 and April 7, four large earthquakes were registered at Kew Observatory. The first, on March 8, started recording at 04h. 56m. 35s. U.T., had a maximum of 32 μ at Kew at 05h. 14m. 26s. U.T. and finished recording at 06h. 30m. U.T. It may have started at an epicentral distance of 3,900 km. The second, on March 19, began recording on all three components at 12h. 19m. 42s. U.T., had a maximum of 17 μ at 12h. 42m. 12s. U.T. and finished recording at 13h. 50m. U.T. The third, on March 21, began recording at 23h. 33m. 38s. U.T., possibly from an epicentral distance of 10,200 km., had a maximum of 155 μ at 22d. 00h. 19m. 37s. U.T., and finished recording at 02h. 15m. U.T. This shock was also well recorded at Stonyhurst. The fourth was on March 22. It began recording at 02h. 17m. 18s. U.T. from a possible epicentral distance of 6,700 km. and finished at 03h. 50m. U.T.

Earthquake of April 8 in the Philippines

IN NATURE of April 18 reference was made to an earthquake of considerable severity (probably submarine) in the neighbourhood of the Philippines on April 8. This shock and two smaller aftershocks were recorded at Bombay. The Rev. J. P. Rowland, S.J., obtained a beautiful record of this earthquake on the Milne-Shaw seismograph at Stonyhurst College Observatory. The tentative readings of this seismogram tend to support an epicentre near the Philippines as suggested by Riverview. The shock began recording at Stonyhurst on April 8 with i at 15h. 58m. 00s. U.T., had a maximum at 16h. 34m. 30s. U.T. and finished recording at 18h. 31m. U.T.

The Association of Scientific Workers

THE Association of Scientific Workers is holding its annual council meeting during May 2–3 at the London School of Hygiene and Tropical Medicine, Holborn, W.C.1. The Association has increased its membership from two to more than five thousand in the past year and has recently been affiliated to the Trades Union Congress. The main items for discussion will be the ways in which scientific workers and engineers can aid war production, and the need for improved professional status and educational facilities.

Following upon a memorandum from the Central London Branch of the Association of Scientific Workers, the Executive has set up a provisional Medical Sciences Committee "to further the objects of the A.Sc.W. among scientific and technical workers concerned with the medical and ancillary sciences". The provisional Committee has the immediate task of bringing together all members working in this field, as well as people anxious for the best application of knowledge in their place of work and for the war effort in general. The first meeting will be held on May 9 at 3 p.m. in the Small Conway Hall, Red Lion Square, W.C.1. Further information can be obtained from Dr. J. H. Humphrey, 32 West Hill Court, Millfield Lane, London, N.6.

Night Sky in May

FULL moon is on April 30d. 21h. 59 m. U.T. and new moon on May 15d. 05h. 45m. Full moon occurs on May 30d. 05h. 29m. Lunar conjunctions with the planets occur as follows: Venus on May 11d. 07h., Venus 0·6° N.; Mercury on May 17d. 04h., Mercury 7° N.; Jupiter on May 17d. 20h., Jupiter 5° N.; Mars on May 19d. 13h., Mars 6° N. Mercury, Mars and Jupiter are evening stars, and Saturn is also an evening star until May 23, then a morning star. Venus is a morning star and rises about 3h. in the middle of the month. Mars, Jupiter and Saturn can be observed in the evening hours, but Saturn is too close to the sun to be observed well. Mercury is in conjunction with Saturn on May 5d. 10h., Mercury 3·8° N. The chief occultation occurs on May 16d. 11h. 35·8m. when α Tauri disappears, reappearance taking place at 12h. 55·9m. The Aquarid meteor shower is active during May 4–11. The radiant is close to η Aquarii about the middle of the period of activity of the shower, which is associated with the debris of Halley's Comet.

Announcements

We regret to announce the death of Prof. Jean B. Perrin, For. Mem. R.S., formerly of the Faculty of Sciences at the Sorbonne, Paris, at the age of seventy-one, on April 17.

MAJOR HARRY G. ARMSTRONG, in charge of research at the United States School of Aviation Medicine at Randolph Field, Texas, has been given the John Jeffries award of the American Institute of the Aeronautical Sciences in recognition of his researches in the physiological and psychological effects of flying at high altitudes and in high-speed manœuvres.

THE Nutrition Society is planning a whole-day conference on "Problems of Collective Feeding in War-time", to be held at the London School of Hygiene and Tropical Medicine, on Saturday, May 30, beginning at 11 a.m. Further information can be obtained from Dr. Leslie J. Harris, Dunn Nutritional Laboratory, Milton Road, Cambridge.

CAPTAIN L. F. PLUGGE, M.P., chairman of the Parliamentary and Scientific Committee, recently wrote to Dr. Hugh Dalton, president of the Board of Trade, about the clothing needs of scientific research workers and chemists. In his reply, Dr. Dalton said that research workers who require only a few overalls in the course of a year will not get extra coupons; an award to be made early next month will, however, provide for those who needs are really very heavy.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The X-Ray Microscope

IN NATURE of April 22, 1939, I described an optical method of summing a double Fourier series, and so of producing an image of a crystal structure. To get a projection of the structure in a direction parallel to the b axis, for example, holes are drilled in a brass plate in the positions of cross-grating spectra. Each X-ray reflexion *hol* is represented by a hole the area of which is proportional to F (*hol*). When a parallel monochromatic beam passes through these holes, and then through a lens, the Fraunhofer fringes build up an image of the crystal structure which can be viewed through a microscope. Since a wide range of holes is required, and they are one or two millimetres apart, the smallest holes must be very fine. I am indebted to Dr. E. W. Fish for supplying me with a series of minute drills.

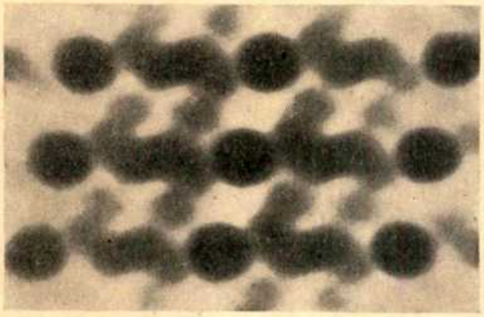


Fig. 1.

INTERFERENCE PATTERN (DIOPSIDE)

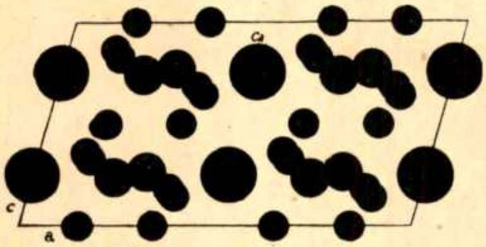


Fig. 2.

STRUCTURE OF DIOPSIDE, $CaMg(SiO_3)_2$, PROJECTED ON (010).

The present note describes certain simplifications in this method, and improvements in the perfection of the image. In the first place, we have found it possible to use a photographic reproduction of a diagram representing the cross-grating spectra in place of the plate drilled with holes. The paths of the waves issuing from the holes must be true to a fraction of a wave if the method is to work. To achieve this, advantage has been taken of one of the filmless photographic processes developed by the British Scientific Instrument Research Association. A drawing of the cross-grating spectra (represented by black dots of appropriate size) is photographed on a much reduced scale on a special type of plate. I am deeply indebted to Mr. A. J. Philpot, director of the Association, and Mr. Haigh, for making these reproductions for us. The black spots become transparent holes in the reproduction, and as there is no film over these holes and an optically true glass plate is used, the conditions for interference are satisfied. These photographs are much more perfect than the series of holes in a plate, and there is no restriction upon the complexity of the drawing.

Fig. 1 shows a photograph of an interference pattern representing diopside, $CaMg(SiO_3)_2$, the structure used to illustrate the method in the former note. This photograph was obtained with one of the plates prepared for us by the B.S.I.R.A. If it is compared with the former photograph, the considerable improvement in definition and extent of the pattern will be obvious. In Fig. 2 a diagram of the structure obtained by X-ray analysis is shown for comparison with the optical image, the atoms being represented by black dots.

In the case of diopside, F (*hol*) is positive for all values of h and l except (202). In the general centro-symmetrical case, both positive and negative values occur, so that a retardation to a path-difference of $\lambda/2$ must be introduced at the appropriate holes. We have found that this can be realized for two holes by cutting a half-wave plate of mica into small squares. To introduce a difference of $\lambda/2$, mica squares are placed one over each hole but with their fast axes at right angles. It is not necessary to polarize the light. This method might be extended to many holes, but the technical difficulties are rather considerable. It should be emphasized that the difficulties arise because path-differences must be right to a fraction of a wave; hence the squares must be cut from an extremely uniform mica sheet.

In making a Patterson synthesis, F^2 values are used and all coefficients are positive. Fig. 3 is an enlarged contact print of a B.S.I.R.A. plate representing the F^2 values of a horse methæmoglobin crystal measured by Perutz[1]. Fig. 4 shows the Patterson synthesis obtained by optical interference using this plate. The pattern on the photograph corresponds in detail to the distribution of maxima on the contour map obtained by calculation (see Fig. 5). Although the phases are all positive and thus present no trouble, another technical difficulty is encountered in the case of Patterson syntheses by interference. The constant term is large compared

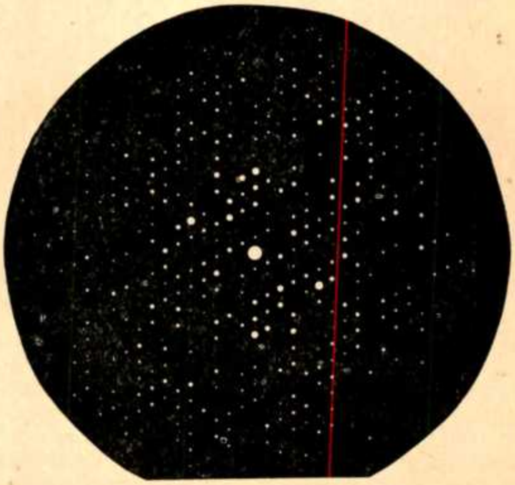


Fig. 3.

PRINT OF B.S.I.R.A. PLATE, HÆMOGLOBIN SPECTRA.

with the coefficients F^2, and hence the central hole has to be much larger than the others. On the other hand, it must be so small that its first diffraction fringe falls well outside the central cell of the pattern, since the reproduction is only true inside the central diffraction maximum. In the present case this maximum is made to cover one complete repeat of the Patterson pattern by making the diameter of the central hole less than half the distance between neighbouring spectra. This requirement sets the scale for all the spots in Fig. 3. The method promises to be useful for the rapid summation of Patterson-Fourier series.

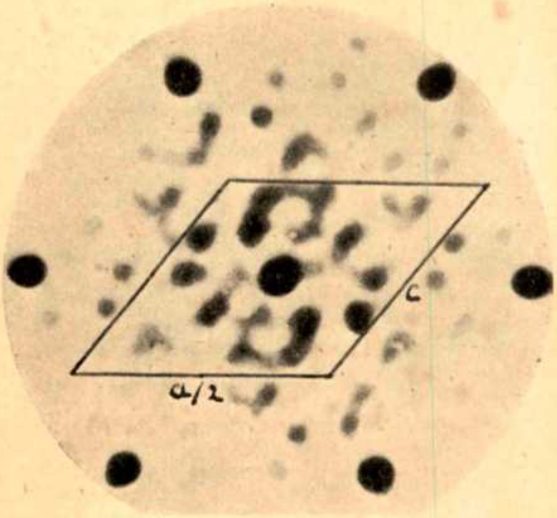


Fig. 4.
PATTERSON INTERFERENCE PATTERN (HÆMOGLOBIN).

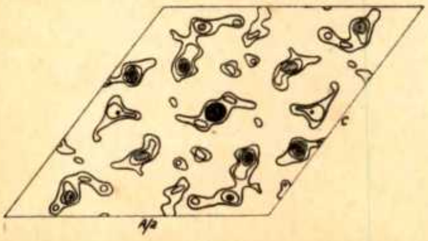


Fig. 5.
PATTERSON SYNTHESIS BY PERUTZ, TO BE COMPARED WITH FIG. 4.

When taking photographs of the images, we have found it advantageous to use a filter to select monochromatic light from a mercury vapour lamp, and to place the panchromatic plate so as to receive directly the image formed by the microscope objective. The exposures are of a few minutes duration. If the photographs are made in a camera attached to the eyepiece of the microscope, exposures of several hours are required and the images are less perfect. I wish to express my thanks to the General Electric Company for the gift of the lamp used for this purpose, and to my assistant Mr. Crowe who has taken the photographs.

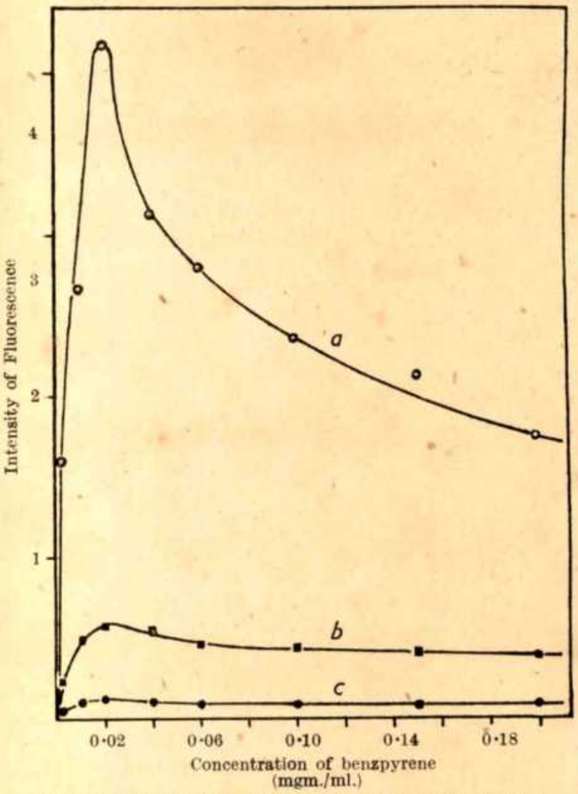
W. L. Bragg.

Cavendish Laboratory,
Cambridge.
March 31.

[1] Perutz, M., NATURE, in the press.

Reversible Quenching by Oxygen of the Fluorescence of Polycyclic Hydrocarbons

During an investigation into the estimation of 3 : 4-benzpyrene by fluorescence measurements, great differences in fluorescence intensity were observed according to the solvent used; for example, the fluorescence is about five times as intense in tetraline as in hexane. These differences were found to be entirely due to a quenching effect of dissolved oxygen. In the absence of oxygen, the fluorescence intensity curves of a series of benzpyrene concentrations are practically identical in all the solvents studied. The most striking feature of the quenching by oxygen is its complete and instantaneous reversibility. The fluorescence of a given solution which has been almost completely quenched by oxygen is immediately and completely restored to its original value if the oxygen is pumped off, and this cycle can be repeated indefinitely.



FLUORESCENCE INTENSITY OF 3 : 4-BENZPYRENE IN HEXANE SOLUTION
(*a*), *in vacuo*; (*b*), in air; (*c*), in oxygen at 1 atm. pressure.

In the accompanying graph the intensity of fluorescence (in arbitrary units) of 3 : 4-benzpyrene in hexane solution is plotted against its concentration for vacuum, air and oxygen of 1 atm. pressure. In the latter case the quenching amounts to about 97 per cent. At very low concentrations of benzpyrene the (unquenched) fluorescence increases almost linearly with concentration due to the correspondingly increasing light absorption in this region, whereas at higher concentrations the fluorescence yield decreases, obviously due to a 'self-quenching' effect.

A quenching effect by oxygen has previously been observed by Bowen and Norton[1] for solutions of anthracene in various solvents, and by Kautsky[2] and

Franck and collaborators[3] for chlorophyll solutions. In these cases, however, the effect is much smaller. The accompanying table shows the result of measurements with polycyclic hydrocarbons (some of them carcinogenic) and some other fluorescent substances under comparable conditions. Wherever a quenching effect of oxygen was observed, it was completely reversible.

PERCENTAGE QUENCHING OF FLUORESCENCE BY OXYGEN AT 1 ATM. PRESSURE IN ETHANOL SOLUTIONS CONTAINING 0·01 mgm./ml.

Anthracene	60·0
Chrysene	85·7
Pyrene	87·7
Rubrene	68·0
1 : 2-Benzanthracene	86·3
9 : 10-Dimethyl-1 : 2-benzanthracene	86·7
1 : 2 : 5 : 6-Dibenzanthracene	88·2
3 : 4-Benzpyrene	91·7
20-Methylcholanthrene	86·6
Ethyl chlorophyllide	32·1
Eosine	0
Thiochrome (in *iso*-butanol sol.)	27·5
Quinine sulph. (in 0·1 N H_2SO_4 in methanol ...	17·5
Acridine " " " "	0

Every elementary process of quenching is represented by a chemical reaction. The well-known ability of the polycyclic hydrocarbons to form photo-oxides[4] suggests the following primary process:

$$(HC)^* + O_2 \rightarrow (HC)^+ O_2^- \rightleftharpoons (HC)O_2,$$

where the optically excited hydrocarbon molecule $(HC)^*$, which has a lower ionization potential, transfers an electron to the oxygen molecule, thereby forming the photo-oxide, which is partially ionic in its character[5]. This process, which is reversible, suggests a type of reversible oxidation-reduction of the hydrocarbon.

It seems that the 'self-quenching' which is observed at higher concentrations of the fluorescent substance can be interpreted by an elementary process:

$$(HC)^* + (HC) \rightarrow (HC)^+ (HC)^- \rightleftharpoons (HC)_2,$$

where the excited hydrocarbon molecule $(HC)^*$ reacts with an ordinary molecule (HC), eventually leading to a dimer. It has been shown[6] that anthracene solutions give di-anthracene on irradiation, and it is suggested that in the case of benzpyrene (and other fluorescent substances where self-quenching occurs) a similar dimerization takes place under the influence of light which in general is reversible in the dark. This is supported by our observation that in this region the fluorescence yield can often be represented by the common hyperbolic equation if the total concentration of the hydrocarbon in solution is substituted for the concentration of the quenching substance.

We are greatly indebted to Dr. F. Dickens for many valuable discussions, and to Prof. J. W. Cook, who supplied some of the hydrocarbons used.

H. WEIL-MALHERBE.

Cancer Research Laboratory,
North of England Council of the
British Empire Cancer Campaign,
Royal Victoria Infirmary.

Department of Chemistry, JOSEPH WEISS.
King's College,
University of Durham,
Newcastle-upon-Tyne.
April 2.

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[1] Bowen, E. J., and Norton, A., *Trans. Faraday Soc.*, **35**, 44 (1939).

[2] Kautsky, H., *Ber. dtsch. chem. Ges.*, **64**, 2677 (1931).

[3] Franck, J., and Levi, H., *Z. physik. Chem.*, B, **27**, 409 (1934).

[4] Cook, J. W., Martin, R., and Roe, E. M. F., NATURE, **143**, 1020 (1939).

[5] Weiss, J., NATURE, **145**, 744 (1940).

[6] Luther, R., and Weigert, F., *Z. physik. Chem.*, **51**, 297 (1905); **53**, 385 (1905).

A New Salmonella Type

A NEW Salmonella type has been isolated by us from the mesenteric gland of a normal pig. It ferments, with the production of acid and gas, glucose, mannitol, arabinose, dulcitol, rhamnose, trehalose, sorbitol, lævulose, mannose, galactose and xylose; and does not ferment lactose, sucrose, adonitol, erythritol, inulin, raffinose and salicin. It is indole-negative and H_2S-positive, reduces nitrates to nitrites and does not hydrolyse urea; in Stern's medium it is positive; in Bitter's medium it is positive with glucose, arabinose and rhamnose, and negative with dulcitol; on Simmons' agar it is positive with glucose, arabinose, dulcitol and rhamnose; it does not liquefy gelatine and is *d*-tartrate-, *l*-tartrate-, mucate- and citrate-positive. Its antigenic structure is $VI_1.VIII$; $\longleftrightarrow e,n\ldots$(phase 2 is still under examination).

We suggest the name *S. bonariensis* for this new type.

J. J. MONTEVERDE.

Facultad de Agronomía y Veterinaria,
Catedra de Bacteriología,
Buenos Aires.
March 17.

Structure of the Branchiæ of *Carcinus maenas*

NOTHING is known concerning the histology of the branchiæ of *Carcinus mænas*, except for a brief account using Bouin-fixed material[1]. By fixation in Champy, whole-mount preparations of strips of a lamella stained in iron alum hæmatoxylin show that a system of branching tube-like structures is present.

The exact morphology of these structures is difficult to determine, but it is believed that they are tubes or sculpturings in the cuticle. Seen from above (*P*, Fig. 1) they form a series of connected systems extending radially out from certain areas, corresponding in position with the large pillar cells (*E*), which lie directly beneath.

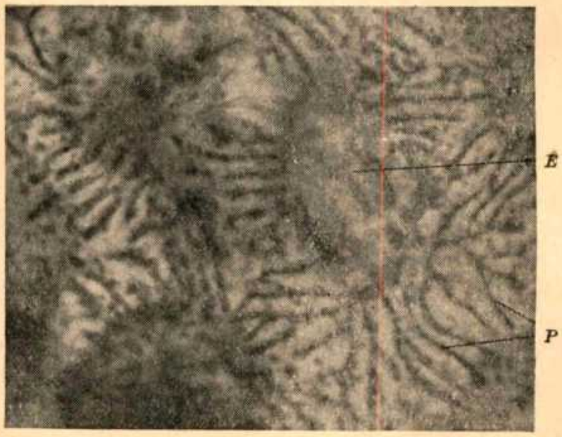

Fig. 1.

In transverse section of the lamella, shown diagrammatically in Fig. 2, the structures are seen as a series of dark striations (P') in the cuticle (C). Directly below these a number of tubes (T) extend deeply into the pillar cells, apparently forming a continuous arrangement with those of the cuticle.

There is no evidence available as to the possible function of these structures; but it is suggested that they form a tubular system whereby the water is enabled to come into close contact with the pillar cells, and thus assist in the oxygenation of the blood circulating between these cells.

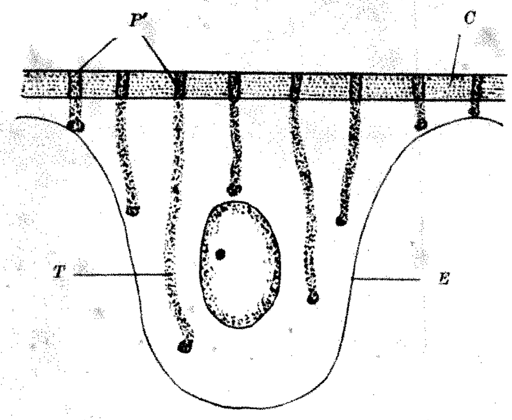

Fig. 2.

J. D. **Smyth.**

Department of Zoology,
Trinity College,
Dublin.
Feb. 3.

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[1] Webb, D. A., *Proc. Roy. Soc.*, B, **129**, 107 (1940).

Committee Decisions and Mathematical Statistics

Dr. Blakeslee is surprised that there is not a higher degree of unanimity of the Supreme Court of the United States[1], but a believer in the subjectivity of opinion would expect very much what Dr. Blakeslee records in the tantalizingly few data he gives. In some matters there can scarcely be two opinions. But the ordinary matters of government are commonly settled by committee decisions—of which those of the Supreme Court are a type—or else by the decision of some one man. If the values of the opinions of men *inter pares* are equal, one would premise first, that a wrong decision is equally as likely to emerge as a right one from subjective processes; and secondly, in relation to complex and obscure questions such as those with which superior courts necessarily deal, that the voting would correspond to some distribution of mathematical probability. Some critiques of examination results ("examinations of examiners") support these views[2]. It would be interesting to know how often a decision of a lower court of law is reversed or upheld by a higher.

Referring solely to a committee of nine members, all of whom vote, I may point out that if decisions were absolutely random the distribution of judgments in which the members were unanimous, or divided 8–1, 7–2, 6–3 and 5–4, would follow the binomial distribution ($n = 9$) 1, 9, 36, 84, 126. Thus a unanimous decision could be expected only once in 256 cases, and an 8–1 or a unanimous decision once in 25. The 6–3 and 5–4 decisions would constitute more than three-quarters ($\frac{210}{256}$) of all the decisions, and a decision of a higher degree of unanimity than 6–3 would occur only once in five or six cases.

Though the data supplied by Dr. Blakeslee are too few to have more than coincidental value, it is interesting to note that the two 6–3 and three 5–4 decisions he mentions are precisely in the ratio indicated by the binomial hypothesis. May I hope that someone with access to recorded decisions of the Supreme and other courts would examine them from the point of view of this hypothesis?

I am not concerned to question the value of Supreme Court decisions in particular, and I mention that Court only because there is evidently a body of its recorded opinions and of votings such as exists for few other committees. But if the subjectivity of committee judgments can be established, we may advance some way towards putting democracy on a factual basis. Much scorn has been poured on Hitler's "intuition", but it is not clear that the Allies have used any sounder method of attacking many of their problems. Yet the United States and the British Empire have virtually sole command of mathematical statistics, which is the only objective method of analysis of complex problems and offers the only way of assessing the validity of an analysis. Mathematical statistics is presumably not applicable to legal questions, nor to essentially subjective matters such as foreign policy; but it is applicable to many problems involving numerical data—such as those of supply, production and distribution. While the Allies continue to rely upon the decisions of committees or 'strong men' for problems capable of being objectively solved, they are disregarding the greatest intellectual advantage which they enjoy over their enemies.

Hugh **Nicol.**

35 Tennyson Road,
Harpenden, Herts.
April 7.

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[1] Nature, **149**, 288 (1942).

[2] Nature, **136**, 966 (1935).

Physiology of the Amino Acids

The valuable and comprehensive review by Dr. van Slyke[1] fails to discuss one problem, the most important of all from the point of view of human nutrition. Accepting W. C. Rose's classification of amino acids into essential and non-essential, he has omitted to make clear, though it is implicit in his review, that this information applies only to experimental animals, indeed, only to the experimental rat. It would be interesting to know what evidence, direct or indirect, exists, if any exists, as to the indispensability or dispensability of any individual amino acid for *Homo sapiens*.

A. L. **Bacharach.**

Glaxo Laboratories Ltd.,
Greenford,
Middlesex.

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[1] Nature, **149**, 342 (1942).

RESEARCH ITEMS

Biological Estimation of Vitamin P Activity

A. L. Bacharach and M. E. Coates discussed this subject at a meeting of the Society of Public Analysts and Other Analytical Chemists held on April 1. Modifications of Zecho's method for measuring capillary resistance in guinea pigs having revealed its suitability as a basis for biological estimation of vitamin P, a provisional laboratory standard has been assigned the value of 1,000 units per gram: this material (W.S.P.1) is a water-soluble concentrate, similar to Szent-Györgyi's 'citrin', made from citrus peel. Recrystallized hesperidin has been found to have an activity of 95 units (probable limits of error, for $P = 0{\cdot}95$, 73–138 per cent), while a water-soluble concentrate made from blackcurrants has the high value of 10,600 units per gm. (probable limits of error, 79–126 per cent). Tests of this degree of accuracy are conducted on thirty to forty young guinea pigs, using two doses of standard and two doses of unknown. Rough exploratory tests, using six animals, have confirmed the presence of vitamin P in other citrus concentrates, in a reaction mixture obtained by partial esterification of highly purified hesperidin, in rose-hips and rose-hip syrup, in blackcurrant juice (pasteurized) and in blackcurrant *purée*.

A Modified Hilger Vitameter A

AT the meeting of the Society of Public Analysts and Other Analytical Chemists held on April 1, R. J. Taylor described a modified instrument for estimating vitamin A. Greater accuracy of calibration is attained by using, instead of a standard glass test piece, a dilute solution of a dyestuff, benzene-azo-*p*-cresol. This has an absorption curve resembling that of vitamin A with a maximum at 325 mμ; its E (1 per cent, 1 cm.) value can be determined accurately by means of a spectrophotometer, and its use automatically eliminates any small error in cell thickness. The modifications made in the instrument itself are: (*a*) a more versatile electrode holder, which reduces fluctuations of the copper arc, (*b*) a light-tight photographic paper holder, and (*c*) a pendulum type photographic shutter, giving a succession of short exposures instead of a single longer exposure at any one setting. After approximate visual setting, records are taken on a piece of gas-light paper at a series of neighbouring settings, from which the correct setting is ascertained. The instrument need not be operated in a darkened enclosure. The overall error has been reduced from about ± 10 per cent to about ± 3 per cent.

Constitution of Yeast Mannan

YEAST mannan, which is a polysaccharide extracted by alkali from baker's yeast, was shown by W. N. Haworth, Hirst and Isherwood in 1937 to be essentially homogeneous and composed exclusively of mannose residues, and its acetate and methylated derivative were studied. A further examination of the substance has been made by W. N. Haworth, R. L. Heath and S. Peat (*J. Chem. Soc.*, 833; 1941). It is shown that tetramethyl mannose, trimethyl mannose and dimethyl mannose are produced on methylation and that the tetra-fraction consists of tetramethylmannose and the di-fraction of 3 : 4-dimethyl mannose. The tri-fraction, however, is not constituted entirely of 2 : 3 : 4-trimethyl mannose; this sugar, in fact, does not make up more than 10 per cent of the tri-fraction. The main constituents are 3 : 4 : 6-trimethyl mannose and 2 : 4 : 6-trimethyl mannose, which are present in equimolecular proportion and together constitute 90 per cent of the fraction. This result throws light on the probable structure of yeast mannan, which is considered in the paper. The repeating unit of yeast mannan would appear to be composed of six mannose residues linked in such a way that two residues give rise to tetramethyl mannose, two yield 3 : 4-dimethyl mannose, one gives 3 : 4 : 6-trimethyl mannose, and one forms 2 : 4 : 6-trimethyl mannose. Alternative formulæ are discussed.

Geology of the Weald

THE geology of the Weald was formerly much studied, but then largely dropped as exhausted of interest. In the last few years, however, a good many valuable contributions have appeared, and a recent paper by P. Allen, "A Wealden Soil Bed with *Equisetites lyelli* (Mantell)" (Weald Research Committee, Pub. No. 31), is one of the fruits of the more intensive modern studies (*Proc. Geol. Assoc.* **52**, 362; 1941). One of its main findings is that fossil soil beds containing the underground parts of a large reed-like plant, *Equisetites lyelli*, in position of growth are widespread, thus proving the existence of terrestrial even if swampy conditions; and there are indications that these conditions occurred repeatedly. The underground organs of *E. lyelli* had been previously described, but their nature was not fully realized, and the species was ill characterized although it had been reported from the lowest Cretaceous rocks of various European and American localities. The present description of the rather thick elongated rhizome and the unbranched aerial stems makes this one of the best-known species of its genus.

A High-Voltage H.R.C. Cartridge Fuse

IN a paper read on April 15 in London before the Institution of Electrical Engineers, K. Dannenberg and W. J. John describe the construction of the two-element, powder-filled cartridge fuse and its effect on protection technique. The provision made for adapting the fuse for oil-immersion, and the striker-pin mechanism which ensures tripping on all three phases should only one fuse be blown, are described in detail. Discrimination in operation between fuses and other protective gear is discussed. Experiments are mentioned which show the ability of powder to prevent corona formation on the fusible conductor. A reduction in the magnitude of the transient voltages produced on fuse operation can be obtained by changing the section of the fusible conductor in one or more places. A series of tests on the behaviour of high-voltage fuses on short-circuit in an ordinary 50-c./s. system is presented and typical oscillograms are given. A test is also described which reproduces the operating conditions obtained when a rectifier backfires, and oscillograms are given showing the behaviour of the fuse under such a test. Fuses like those described have been developed for a rupturing capacity up to 1,000 Mva. at 66 kv. It is suggested that h.r.c. fuses can be used to improve fuse-switches, to act as a back-up to safeguard old circuit-breakers in cases where the short-circuit burden has been increased, and in combination with a simple load-breaking switch in which the switch deals with small overloads only, all short-circuits and heavy overloads being cleared by the fuse.

STALIN PRIZES FOR SCIENTIFIC STUDIES

IT is announced by the Tass Agency that the following awards of Stalin Prizes for outstanding scientific work in 1941 have been made by the Council of People's Commissars of the U.S.S.R.

Physics and Mathematics

First prizes (200,000 roubles each) to:

Serguey Bernstein, member of the Academy of Sciences of the U.S.S.R., for studies in mathematics "On Sums of Dependent Quantities with Mutual Regression Approaching Zero", "On the Approximation of Continuous Functions by Linear Differential Operator of a Multimolal", and "On Fisher's Probabilities".

Abram Joffe, member of the Academy of Sciences of the U.S.S.R., director of the Leningrad Institute of Physics and Technology, for studies in semiconductors published in his work "Semiconductors in Physics and Technology".

Leonid Mandelstam and Nikolai Papaleksi, members of the Academy of Sciences of the U.S.S.R., for studies on the theory of the oscillation and spread of radio waves.

Second prizes (100,000 roubles each) to:

Alexander Alexandrov, of the State University of Leningrad, for studies on the "Existence of a Convex Polyhedron and Convex Surface with Given Metrics" and "The Internal Geometry of Convex Surfaces".

Vladimir Kuznetsov and Maria Bolshanina, of the Kuibyshev State University in Tomsk for a study of "The Physics of the Solid Body".

Technical Sciences

First prizes (200,000 roubles each) to:

Boris Kalerkin, member of the Academy of Sciences of the U.S.S.R., for his studies in the theory of elastic equilibrium of cylindrical casings, together with the work on "Tensions and Changes in Circular Cylindrical Piping".

Sergei Khristianovich, corresponding member of the Academy of Sciences of the U.S.S.R., of the Central Zhukovsky Aero-hydrodynamic Institute, for a study on "The Flow of Gas around a Body at High Sub-sonic Speeds", "The Efficacy of Compressibility on Characteristics on Wing Contour", "Super-sound Flows of Gas".

Second prizes (100,000 roubles each) to:

Metislav Keldysh and Eugenii Grossman, of the Central Zhukovsky Aero-hydrodynamic Institute, for studies in the prevention of breakdown of planes, "Calculation of Flutter in Aeroplanes", "Oscillation of a Wing with Elastically Attached Engine" and others.

Chemical Science

First prize (200,000 roubles) to:

Nikolai Zelinsky, member of the Academy of Sciences of the U.S.S.R., for outstanding contributions to organic chemistry.

Second prizes (100,000 roubles each) to:

Ilya Grebenshchikov, member of the Academy of ciences of the U.S.S.R., director of the State Optical Institute, for studies in optics of great significance or defence.

Peter Rebinder, corresponding member of the cademy of Sciences of the U.S.S.R., for his studies The Importance of Physical and Chemical Processes n the Mechanical Destruction and Treatment of Solid Substances in Technology" and "The Acceleration of Deformation of Metallic Single Crystals under the Influence of Absorption of Superficially Active Substances".

Geological and Geographical Sciences

First prizes (200,000 roubles each) to:

Alexander Fersman, member of the Academy of Sciences of the U.S.S.R., director of the Institute of Geology, for his study "Useful Minerals of the Kola Peninsula".

Akhad Yakubov, vice-chairman of the Azerbaidjan Branch of the Academy of Sciences of the U.S.S.R., for the study "Mud Volcanoes of the Western Part of the Apsheron Peninsula and their Connexion with Oil Bearing".

Second prizes (100,000 roubles each) to:

Kanysh Satpayev, vice-chairman of the Presidium of Sciences of the U.S.S.R., for the study "Ore Deposits in Dzhezkazghan District of the Kazakh Republic".

Vasilii Shuleikin, corresponding member of the Academy of Sciences of the U.S.S.R., director of the Black Sea Hydrotechnical Station, for a study "Physics of the Sea".

Biological Sciences

First prize (200,000 roubles) to:

Yakov Parnos, of the Institute of Biochemistry of the Academy of Sciences of the U.S.S.R., for research in metabolism in muscles published in the work "Glycogenolysis".

Second prizes (100,000 roubles each) to:

Alexei Zavarzin, of the All-Union Institute of Experimental Medicine, for the study on the "Evolutionary Histology of the Nervous System".

Sergei Ognev, of the State University of Moscow, for the study on "Animals of the U.S.S.R. and Neighbouring Countries".

Economic Science

First prize (200,000 roubles) to:

Vladimir Komarov, president of the Academy of Sciences of the U.S.S.R., jointly with the following members of the Academy of Sciences: Ivan Bardin, Ergard Britske, Vladimir Obraztsov, Stanislav Strumlin, Lev Shevyakov, and Profs. Veniamin Veits, Nikolai Kolossovsku, Vassilii Kozlov, Boris Kuznetsov, Roman Pevzner, Abram Probst, David Chizhikov, and the scientific workers, Vladimir Galperin, Mikhail Rastsvetayev, Vyacheskav Rikman, Boris Gurevich, Ivan Doroshev, Mikhail Stekolnikov, for their joint work on the "Economic Development of the Urals in War Conditions".

Agricultural Sciences

First prizes (200,000 roubles each) to:

Johann Eichfeld, member of the Lenin All-Union Academy of Agricultural Sciences, director of the All-Union Institute for the Cultivation of Plants, for well-known works on the "Theory and Practice of Agriculture in the Extreme North of the U.S.S.R.".

Second prizes (100,000 roubles each) to:

Mikhail Dyakov, director of the Pushkin Zoo-Technical Laboratory, for works on the feeding of agricultural cattle and the elaboration of the foundations of the combined fodder industry.

Leonid Prassolov, member of the Academy of Sciences of the U.S.S.R., director of the Dokuchaev Soil Institute, for compilation of soil maps of the European part of the U.S.S.R. and elaboration of methods of calculation of land resources.

Medicine

First prizes (200,000 roubles each) to:

Alexei Abrikosok and Nikolai Anichkov, members of the Academy of Sciences of the U.S.S.R., for their studies on "Pathological Anatomy: Heart and Vessels".

Sergei Spasdkukopsk, of the Second Moscow Institute of Medicine, for well-known work in surgery and for the study "Actinomycosis of the Lungs".

Second prizes (100,000 roubles each) to:

Kolay Petrov, corresponding member of the Academy of Sciences of the U.S.S.R., for studies in oncology and the surgery of ulcers of the stomach and duodenum.

Sergeii Udin, chief surgeon of Sklifassovsky Institute, for his works "Notes on Field Surgery and Artificial Œsophagus", "Notes on Field Surgery", "Treatment of War Wounds with Sulphamide Preparations" and "Some Impressions and Reflections about Eighty Cases of Artificial Œsophagus".

Military Science

First prize (200,000 roubles) to:

Ivan Grave, of the Dzerzhinsky Artillery Academy, for the study "Ballistics of a Semiclosed Space".

Second prizes (100,000 roubles each) to:

Evgenii Barsukov, for the historical study "Russian Artillery in the World War".

Mikhail Dubinin, of the Voroshilov Academy of Chemical Defence of the Red Army, for studies in chemical defence.

History and Philosophy

First prize (200,000 roubles) to:

Vladimir Potemkin, Evgenii Tarle, member of the Academy of Sciences of the U.S.S.R., Vladimir Khvostov, jointly with a number of others for a work entitled "The History of Diplomacy".

Second prize (100,000 roubles) to:

Sergei Rubinstein, of Herzen Pedagodical Institute in Leningrad, for his book entitled "Foundations of General Psychology".

COSMICAL ORIGINS OF THE ELEMENTS

PROF. SUBRAHMANYAN CHANDRASEKHAR, assistant professor of theoretical astrophysics at the University of Chicago, described some results of his investigations of the origin and distribution of the chemical elements of the universe in a paper read during the fiftieth anniversary celebrations of the University of Chicago.

The formation of the lighter elements, including hydrogen and helium, can be accounted for at densities and temperatures not markedly greater than those found at present in the universe, but to account for the formation of heavier elements, such as oxygen, fluorine, neon, sodium, magnesium, aluminium, silicon, phosphorus, sulphur, chlorine, argon, potassium and their isotopes, in their present relative abundance, more extreme conditions are necessary. For the formation of the quantities of these elements in anything like their present relative proportions, the density of a 'pre-stellar' universe of one thousand to one hundred thousand grams per cubic centimetre and temperatures of $6–8 \times 10^9$ degrees seem to be required.

Under such conditions, however, the very heavy elements, like gold and lead, occur only in very small amounts; it thus appears that the pre-stellar stage must have originated at extreme densities and temperatures when the heaviest elements were formed. As the matter cooled to lower densities, the present relative abundances of the moderately heavy elements like silicon and sulphur resulted under conditions of a few thousand million degrees and densities ranging from one thousand to ten thousand grams per cubic centimetre. Finally, the elements lighter than oxygen were formed at a still later stage, when conditions were not very different from those now existing in stellar interiors.

In discussing the formation of energy in giant stars, Prof. Chandrasekhar stated that whereas the Bethe theory successfully accounts for energy production in the sun and similar stars, it fails to explain energy production in the giants. His own calculations show that the production of energy by the lighter elements, including lithium, beryllium and boron, will take place in a spherical shell rather than close to the centre—burning, so to speak, from the centre outward. The energy-generating spherical shell cannot get very far from the centre, leaving only the inner 35 per cent of the star's mass to provide energy; this, he believes, accounts for the presence of the light elements in the atmospheres of the giants.

The theory that supernovæ constitute an intermediate stage in which extremely heavy stars cast off much of their mass in their 'attempt to settle down as white dwarf stars' was put forward by Prof. Chandrasekhar. He pointed to the analysis by Dr. Minkowski, of the Mt. Wilson observatory, of the central star of the Crab nebula, which was identified as the result of a supernova in our galaxy, which 'blew up' in A.D. 1054. His analysis of Dr. Minkowski's results showed that this nuclear star is half-way between the supernova and the white dwarf stage: thus, it will be a white dwarf by approximately the year 2828.

According to the theory of white dwarfs developed by Prof. Chandrasekhar, the upper limit to the masses of white dwarfs is about twice the mass of the sun. Thus, he said, a massive star may undergo great contraction, bringing about the explosion characterizing the supernova.

RECENT RESEARCH IN OCEANOGRAPHY*

By DR. G. E. R. DEACON

THE papers in the most recent number of th *Journal of Marine Research* of the Bingham Oceanographic Laboratory, Yale University, for 194 cover a wide field.

R. B. Montgomery has used four series of observations across the Straits of Florida near Habana t compare the calculated difference of sea-level between the two sides of the Gulf Stream with th figure given by the tide-gauge readings at Key Wes The agreement was poor, and among the mai sources of error new emphasis is given to the di tortion of the picture of the density distributio which is inevitable owing to the change of tide the ship works her way across the strait—taking about sixteen hours to complete the section. Better agreement between calculations and tidal data has been obtained farther north along the U.S. coast, and it is suggested that the exposure of the tide-gauge at Key West is not altogether satisfactory.

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* Sears Foundation for Marine Research. Bingham Oceanograph Laboratory, Yale University. *Journal of Marine Research*, 4, No (1941).

G. L. Clarke has measured the water transparency and light penetration over a large area south of Bermuda as far as the coast of British Guiana. The waters of the Sargasso Sea and North Equatorial Current were clearest; there was less transparency in the more fertile waters nearer the equator and a sharp drop near the South American coast. The measurements were made with photo-electric cells and compared with observations of the depth to which a 'Secchi disk'—a white disk 20 cm. in diameter—could be lowered before it disappeared. The correlation showed a high degree of scatter, but on an average the disk disappeared at a depth where the illumination was 15 per cent of that incident on the surface. The greatest depth to which the disk was seen was 47 m.; the poor agreement with direct measurements is believed to have been due to unfavourable weather conditions and large waves; the disk was viewed directly over the ship's side and not through a tube dipped below the surface.

H. W. Graham has examined the plankton hauls made from the non-magnetic ship *Carnegie* on her last, ill-fated voyage from California to Samoa. The hauls, which were made from a depth of 100 or 150 m., showed a richer plankton in the tropical region, where there is evidence of the upwelling of deep water, than in the southern part of the temperate zone, where there is an accumulation of warm water with less nutrient salts. The author does not mention recent work by Seiwell and Riley, which has an important bearing on the subject.

F. A. Davidson and Elizabeth Vaughan, of the newly constituted United States Fish and Wildlife Service, describe their work on the relations between density of population, size of fish and time of spawning migration for the pink salmon of south-eastern Alaska. Between 1914 and 1920 while the fishery was expanding rapidly the fish declined in abundance, but increased in size and migrated to the rivers at an earlier date. After 1921, when restrictive regulations were introduced, the fish began to regain its former abundance, but decreased in size and migrated later. The authors summarize many influences which have been found to retard growth in a crowded population, such as the production of autotoxins, rowth-inhibiting substances, accumulation of excre-ory products, reduction of available food, and over-stimulation due to increased contacts, but they are nclined to believe that the changes in the pink salmon re mainly the result of the varying competition for ood as the population increases or decreases.

Mary Sears compares the phytoplankton productivity of the shallow water over the Georges Bank n the Gulf of Maine with that of the neighbouring deeper waters. It was found that the period of diatom abundance lasted longer in the shallow water; the deeper waters are as rich or richer during the peak eriod at the end of March, but become relatively arren at the end of a month, while the population f the shallow water falls to a twentieth of its peak alue at the end of three months. The bank was thus found to be one of the most productive areas f the gulf.

C. E. ZoBell has combined the most desirable eatures of many bacteriological water-samplers to produce one which he claims to be non-bactericidal, easily sterilized and capable of aseptic manipulation under the usual collecting conditions. No metal was satisfactory and the containers were made of glass or indiarubber, sealed with a 4-mm. capillary tube attached by pressure tubing. The frame which holds the container is so arranged that the capillary is broken at a file-mark by sliding a 'messenger' down the wire on which the sampler is lowered. The indiarubber containers were used at the greater depths to avoid the effect of the sudden change of pressure on the bacteria when the sample was aspirated through the broken capillary; the containers were sealed hot and full of vapour, straight from the autoclave, and the indiarubber bulb was sent down in a collapsed state, to aspirate a sample as it returned to its normal shape. The possibility of exchange through the capillary while the sampler was being hauled to the surface was not thought to be serious: owing to the continuous reduction of pressure the main movement is outward.

SMOKE ABATEMENT AND RECONSTRUCTION

Many minds are turned to post-war conditions, when problems such as unemployment will coincide with opportunities for reform of layout and rebuilding of cities. The National Smoke Abatement Society has submitted to the Ministers concerned a memorandum on smoke prevention in relation to initial post-war reconstruction in Great Britain (Nottingham: National Smoke Abatement Society, *2d.*).

The memorandum is concerned only with the prevention of smoke in the new building that will take place immediately after the end of the War. Provided that early attention is given to this question, it is considered that practically the whole of this building can be made smokeless.

The memorandum first proposes that the important principle be established of ensuring the use of suitable appliances and plant by requiring all new installations of fuel-burning equipment to have the previous approval of a special authority. By this method, which is common in the United States and elsewhere, both fuel economy and smoke prevention can be promoted.

The complete smokelessness, it is said of commercial buildings, that is, all premises other than industrial and domestic, may be readily achieved and should certainly be assured. Open fires should not be permitted in such premises except in special cases, when the use of smokeless fuels should be made obligatory. Industrial plant of all kinds is included in the proposals for the previous approval of new installations, and in many cases the control should also cover use and maintenance.

Much can be done to improve the standards of heating in domestic houses and flats apart from smoke prevention, but if the requisite attention is given to the problem in good time, it is likely that either the whole or a great part of the new housing could be made completely smokeless. The chief problem appears to be that of the supply of smokeless fuels suitable for open grates and other appliances, which must be correlated with the volume and rate of housing. This and other questions should be examined by a Government committee or board, which should include representatives of Government departments, fuel and appliance industries, and town planning, housing, and smoke abatement authorities.

Smokeless central areas should be established in all large towns. Not only should new premises in such areas be smokeless, but also powers should be given to enforce the smokelessness of existing premises. In this way the whole of the most important area of a town could be made completely smokeless.

Town planning schemes in general should include additional measures for ensuring smoke prevention, especially in relation to the zoning of industry and the establishment of special industrial areas or estates. The possibilities of district heating for all types of area should be fully examined and this method adopted wherever it is found to be advantageous. Committees, national, regional and local, concerned with post-war planning, should be assisted in their work by existing regional smoke abatement committees or others experienced in smoke prevention matters.

Support is given to the proposals that have been made in many quarters for the formulation of a comprehensive national fuel policy and for the establishment of a Ministry of Fuel.

It is a commonplace that post-war reconstruction offers great opportunities. So it was thought after the War of 1914–18, when a departmental committee of the Ministry of Health reported on the same question and commented that "the chief factor in the failure to deal with the smoke evil has been the inaction of the central authority"—to which might be added the local authorities. As the memorandum shows, this is a case where technical knowledge is in front of public and official opinion.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Monday, April 27

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Mrs. Stephen Courtauld: "In the Netherlands Indies" (Kodachrome Films).

Wednesday, April 29

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. R. Fitzmaurice: "The Post-War Home", 10: "Lighting, Heating and Ventilation".

Thursday, April 30

Institute of Fuel (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 2.30 p.m.—Dr. S. G. Ward and Mr. W. J. Morison: "Practical Application of Gas Producers to Road Transport including Passenger Service Vehicles".

Royal Institution of Great Britain (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. J. Salisbury, F.R.S.: "The Weed Problem".*

Friday, May 1

Geologists' Association (in the Geological Society's Rooms, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. V. C. Illing: "Geology Applied to Petroleum".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Master (Graduate in Engineering with works experience) to be responsible for the teaching of Engineering in the Consett Secondary School and Technical Institute—The Director of Education, Shire Hall, Durham (May 2).

Principal of the Walker Technical College, Oakengates—The Secretary for Education, County Buildings, Shrewsbury (May 16).

Head of the Chemistry Department—The Secretary, Robert Gordon's Technical College, Aberdeen (May 30).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 49: Salmon of the River Erne; Results of the Examination of a Small Collection of Scales and Data. By Arthur E. J. Went. Pp. 471–480. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [233

Geological Survey of Great Britain: England and Wales. Wartime Pamphlet No. 23: Jurassic Iron Ores, Cleveland District. By W. Anderson. Pp. 42. (London: Geological Survey and Museum.) 1*s*. 8*d*. [233

Freshwater Biological Association of the British Empire. Scientific Publication No. 6: The Production of Freshwater Fish for Food. By Dr. T. T. Macan, Dr. C. H. Mortimer and Dr. E. B. Worthington. Pp. 36. (Ambleside: Freshwater Biological Association of the British Empire.) 1*s*. 6*d*. [233

British Electrical and Allied Industries Research Association. Supplement to Reference A/T83: Mechanical Behaviour of Bitumen. By W. Lethersich. Pp. 8. (London: British Electrical and Allied Industries Research Association.) 6*s*. [243

Food Value Calculator. (London: Vitamins, Ltd.) 2*s*. 6*d*. [25

Year Book of the Royal Society of Edinburgh, 1940–1941. Pp 100. (Edinburgh and London: Oliver and Boyd.) 5*s*. [94

Ovaltine Research Laboratories. Annual Report (1941). Pp. ii+4 (London: A. Wander, Ltd.) [94

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 61, Part 2, No. 15: On the Estimation of Statistical Parameters. By Dr. A. C. Aitken and Dr. H. Silverstone. Pp. 186–194. (Edinburgh and London: Oliver and Boyd.) 9*d*. [94

Colonial Office: Colonial Development and Welfare in the West Indies. Agriculture in the West Indies. Compiled from Document supplied to the West India Royal Commission, 1938–1939, and othe Sources. (Colonial No. 182.) Pp. vi+280+16 plates. (London H.M. Stationery Office.) 10*s*. net. [9

Bulletin of the Advertising Service Guild. Change No. 3: A Inquiry into British War Production, Part 1: People in Production An Advertising Service Guild Report prepared by Mass-Observation iv+145 galleys. (London: Advertising Service Guild.) 10*s*. [10

Other Countries

Presidencia del Gobierno: Dirección General del Instituto Geografico y Catastral. Anuario del Observatorio Astronómico de Madri para 1942. Pp. 365. (Madrid: Instituto Geográfico.) [23

India Meteorological Department. Scientific Notes, Vol. 8, No. 98 Forecasting the 'Northeast Monsoon' Rainfall of South Madras. B V. Doraiswamy Iyer. Pp. 147–154. (Delhi: Manager of Publications. 6 annas; 7*d*. [1

U.S. Department of the Interior: Geological Survey. Wate Supply Paper 836–E: Local Overdevelopment of Ground-Wate Supplies, with Special Reference to Conditions at Grand Islan Nebraska. By Leland K. Wenzel. Pp. iii+233–281+vi+plates 16–2 30 cents. Water-Supply Paper 846: Natural Water Loss in Selecte Drainage Basins. By G. R. Williams and others. Pp. iv+62+ plates. 15 cents. Water-Supply Paper 852: Surface Water Suppl of the United States, 1938. Part 2: South Atlantic Slope and Easter Gulf of Mexico Basins. Pp. vi+293+1 plate. 35 cents. Water-Suppl Paper 853: Surface Water Supply of the United States, 1938. Pa 3: Ohio River Basin. Pp. vii+418+1 plate. 50 cents. Water-Suppl Paper 855: Surface Water Supply of the United States, 1938. Pa 5: Hudson Bay and Upper Mississippi River Basins. Pp. iv+350+ plate. 35 cents. Water-Supply Paper 856: Surface Water Supp of the United States, 1938. Part 6: Missouri River Basin. Pp. viii-419+1 plate. 45 cents. Water-Supply Paper 858: Surface Wat Supply of the United States, 1938. Part 8: Western Gulf of Mexic Basins. Pp. vii+355+1 plate. 40 cents. Water-Supply Paper 862 Surface Water Supply of the United States, 1938. Part 12: Paci Slope Basins in Washington and Upper Columbia River Basin. P vi+177+1 plate. 25 cents. Water-Supply Paper 865: Surfa Water Supply of Hawaii, July 1, 1937, to June 30, 1938. Pp. iv+12 20 cents. Water-Supply Paper 867: Hurricane Floods of Septemb 1938. Pp. iv+562+20 plates. 1.25 dollars. Water-Supply Pap 886: Water Levels and Artesian Pressure in Observation Wells the United States in 1939. By O. E. Meinzer and L. K. Wenzel an others. Pp. v+933. 1 dollar. (Washington, D.C.: Governme Printing Office.) [

Records of the Geological Survey of India. Vol. 76, Bulletins Economic Minerals, No. 8: Clay. By Dr. H. Crookshank. Pp. 2 (Calcutta: Geological Survey of India.) 6 annas; 7*d*. [

Erosion in the Cultivated Uplands of the North Punjab and Cure. By H. M. Glover. Pp. 4+7 plates. (Lahore: Governme Printing Office.) [

Proceedings of the United States National Museum. Vol. 92, N 3133: Notes on Two Genera of American Flies of the Family Tryp tidæ. By John R. Malloch. Pp. 20. (Washington, D.C.: Governme Printing Office.) [

Smithsonian Miscellaneous Collections. Vol. 101, No. 10: Faun Content of the Maryville Formation. By Charles E. Resser. (Pub cation 3676.) Pp. ii+8. (Washington, D.C.: Smithsonian Instit tion.) [

Smithsonian Institution: United States National Museum. Repo on the Progress and Condition of the United States National Museu for the Year ended June 30, 1941. Pp. iii+118. (Washingto D.C.: Government Printing Office.) 20 cents. [

U.S. Department of Agriculture. Leaflet No. 212: The Sa Wireworm. By J. N. Tenhet. Pp. 8. 5 cents. Miscellaneous Pub cation No. 461: Revision of the Bark Beetles belonging to the Gen *Pseudohylesinus* Swaine. By M. W. Blackman. Pp. 32. n.p. (Was ington, D.C.: Government Printing Office.) [

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LEADERSHIP IN INTERNATIONAL RELATIONS*

IN "The Twenty Years' Crisis", Prof. E. H. Carr set out to make a contribution to the science of international relations, but somehow he seemed to lose his way in the maze of power politics. Without any such avowed purpose, he has now given us in "Conditions of Peace"* a constructive analysis in the true scientific tradition, which is a real contribution to the establishment of such a science. It is indeed more than a clear, dispassionate analysis of past ills and present problems; a foreshadowing of future needs ; its calm application of the scientific spirit to world affairs has something of great nobility and vision.

The combined insistence on realism and on learning the mistakes of the past, with the fearless scrutiny of the future, give the book special claims on the interest of scientific workers. Prof. Carr's whole approach is in harmony with the outlook which they are accustomed to bring to bear on their own problems, if not always on those which they face in common with their fellow-citizens. They will recognize instinctively the force of his warning of the danger to the future welfare and prestige of Great Britain of the common inclination to assume that once Nazism is defeated and Germany rendered helpless, the world can with relatively little trouble be re-settled on familiar and comfortable lines. The future, he urges, lies with those who can resolutely turn their back on the old world and face the new world with understanding, courage and imagination.

This call to leadership, which is the dominant note of the whole book, is the complete answer to the vague charges of obscurantism which have found utterance from some of those quarters still looking to the past, as it refutes those who would attempt to maintain the departmentalism or sectionalism of life which has been responsible for so much frustration in the past generation. If democracy is to recover its vitality, to meet the challenge of this present revolution by a redefinition and re-interpretation, science must make its own contribution. The conditions for an orderly and progressive development of human society cannot be worked out without the help both of scientific method and of scientific investigation. Once we begin, as Prof. Carr points out, to put first things first, to determine the conditions for mankind's continuous advance, many of the obstacles to scientific and political co-operation will disappear. When we cease to make peace and security the objects of policy, and policy and plans are formulated to serve clearly ascertained general needs and not private or sectional interests, it will be possible for scientific men to make their contribution to the solution of the economic, social and technical problems involved without detriment to their primary allegiance to science.

That contribution would be the more easily made if scientific workers encountered more often the scientific temper and outlook which characterize Prof. Carr's admirable book. He brings to his survey exactly the quality for which General Smuts pleaded in 1929 in his Sidgwick Memorial Lecture on "Democracy", and there are few scientific workers who will not readily respond to this challenge to thought. He does not attempt to cover the whole field of the future settlement and eschews anything of a blue-print for a peace treaty. He ignores the Far East, and dismisses the United States, the Colonial problem and Russia somewhat cursorily, but within his limits he probes for fundamental principles and the real causes in a way that should inspire equally constructive and imaginative thinking about the problems which he has left alone.

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* Conditions of Peace. By Prof. Edward Hallett Carr. Pp. xxiv + 279. (London : Macmillan and Co., Ltd., 1942.) 12*s*. 6*d*. net.

With its insistence on the factor of leadership, the book is characterized by a breadth and sanity of outlook which sees the whole problem and not merely one section of it, that are badly needed in many circles occupied with reconstruction plans to-day. The relation between domestic policy and foreign policy, the importance of facing reconstruction now and not merely after the War are clearly seen, and a chapter on "Britain at Home" forms as homogeneous a part of the book as those chapters in which he analyses so acutely the theory of self-determination and outlines the new Europe which might be our objective.

In examining the problems of peace from the specific angle of British policy, we must recognize that Great Britain can play no dominant part in the ordering of the world after the War unless the people of Great Britain maintain in time of peace the same sense of common purpose and obligation which has been developed under the impulse of war. Moreover, it is equally inconceivable that we can play a leading part in the reconstruction of the world and leave the structure of society in Britain unchanged and unaffected. What we can achieve in Europe and in the world will grow out of, and is largely dependent on, what we can achieve at home.

In the chapter in which Prof. Carr is urging that we should turn to account in peace the lessons learnt in waging war, and project into post-war reconstruction the organizations or institutions established primarily to serve war purposes, he is once again calling for the forward-looking mind. The opportunities which the imperative need for radical re-planning afford must be seized, and we must recognize that the purpose of our economic system is to produce things wanted for consumption, not things which it is profitable to produce. The bearing of the social minimum not merely on the unemployment problem but also on industrial and agricultural policy and on international reconstruction and relations with the Dominions, the United States and with post-war Europe are outlined tersely but lucidly, and the chapter includes an outline of agricultural policy embodying principles for which scientific workers have long been contending. The emphasis placed on research, like the acute analysis of the weaknesses of party politics in this same chapter, are other points for which scientific workers may well be grateful, and they cannot fail to respond to its challenge to the constructive thought and determined action required to effect the changes essential in our democratic institutions, if democracy is to remain a reality in the twentieth century.

Prof. Carr's insistence on the moral challenge is in striking contrast with the somewhat materialistic note he struck in "The Twenty Years' Crisis". In his glance at democracy he emphasizes the necessity for developing a sense, not only of common benefits to be derived from the State, but also of common obligations, and particularly that of a common responsibility to make democracy work. The democratic ideals of equality and liberty must be reinterpreted in predominantly economic terms, and the new democracy must win the struggle to make political rights effective over economic power. In regard to economic reconstruction, he suggests that the first essential is to draw up an infinitely expansible plan of consumption, with graded priorities, which will assure that our productive forces are occupied to their fullest capacity for its fulfilment, and secondly to substitute welfare for wealth as our governing purpose.

The core of the book lies in the chapter on the moral crisis, in which Prof. Carr outlines the faith and spirit in which the problem of the new Europe and the new order must be approached. The emphasis must lie on positive achievement of good rather than the negative avoidance or suppression of evil. The appeal must be essentially to the individual, to the 'little man', in order to restore his sense of being a constituent member of the community. It must address itself first to the solution of the economic problem, without necessarily expressing itself in economic terms. It must approach the unemployment problem by creating needs vast enough to make a full call on our resources and imperative enough in the moral sphere to command the necessary measures of sacrifice to supply them. The new faith must solve the unemployment problem by providing a moral purpose as potent as was religion in the Middle Ages, or as is war to-day. Its emphasis must be more on obligations than on rights, on services to be rendered to the community rather than on benefits to be drawn from it, and must provide for a similar adjustment in the international field, where a new synthesis of liberty and authority must be achieved.

It is in this spirit that Prof. Carr urges that the immediate post-war activity of the victors should be centred on the economic and social needs of the occupied areas, and that political and constitutional issues should be postponed to a later date. The urgent need is to alter, not the location, but the meaning of frontiers. He argues convincingly as to the impossibility of Great Britain escaping from her responsibilities in Europe, and insists on the imperative necessity of carrying forward unimpaired into the period of peace those forms of co-operation and control which have already been created. We must begin by creating the framework of an international order and then encourage national independence to develop and maintain itself within the limitations of that framework.

Prof. Carr's suggested solution of the German problem is a corollary of this policy of developing new loyalties by giving provisional arrangements an opportunity to demonstrate their value and indispensability. We must help to build up the German economic system into a larger unit under different forms of control, and overcome her belated nationalism by making internationalism worth her while. It is important to defeat Germany by overwhelming force; but it is also important to convince Germans at the earliest possible moment that we have other credentials than force for the reorganization of Europe. The German masses must be given from the outside reasonable convictions that the new order will bring them a higher measure of spiritual, social and physical well-being than the old. Positive incentives to Germans to keep the peace must be provided and opportunities to co-operate in maintaining it.

Without a cogent appeal to the youth of Europe for service to a larger cause there can be little hope of building a new order or solving the many vexed political and economic problems on which Prof. Carr touches with such insight and realism. Some may hold that he is too optimistic and dispassionate in his estimate of Germany, but as to the need for a new spirit, an unprejudiced mind and a sense of values there can be no question, and even those who may think him too cautious can scarcely fail to admit the accuracy of much of his diagnosis and the value of the suggestions he so tentatively advances.

Moreover, there is already evidence of a substantial volume of opinion in harmony with Prof. Carr's views. E. Müller-Sturmheim in his thoughtful article, "Germany as a Spiritual and World Problem" in the *Quarterly Review* of October last, outlined very similar conditions designed to make it impossible for the German people to re-establish their war machine, and at the same time to convince them that their real national and political unity are safeguarded without soldiers or armaments. Any permanent solution must free the German robot from the fear of encirclement inspired by his leaders, and at the same time free him from the unrestricted rule of a total militarism. When, as Müller-Sturmheim points out, the hearts and minds of the German people are thereby opened to the voices of those great Germans whom militarism has hitherto deprived of their influence, the firm integration of Germany into a new world order will be immensely facilitated.

Much the same idea that the new organization of Europe should be directed so as to divorce national structures from military and industrial power, and should be backed by a world control of raw materials and communications, with the dual object of faciliating economic expansion and thwarting policies of autarchy and militarism by automatic sanctions, is o be found in the P E P broadsheet, "The Future of Germany". This broadsheet visualizes the post-war settlement of Europe along the lines of the British Commonwealth, rather than with a written constitution. From this point of view even the disruption of Germany into its original large units existing before 1871, suggested by Dr. P. Einzig in his recent book*, is not necessarily contrary to the modern trend towards larger and more closely integrated units if the original German States are re-integrated, not into a German, but into a European unit.

Dr. Einzig's study of appeasement is scarcely less searching than Prof. Carr's analysis, but his treatment of the German problem is more drastic and far-reaching. Even those who regard his proposals as too provocative cannot disregard his sombre warning against the danger of economic appeasement and the dominance of purely financial interests. Dr. Einzig, it is true, may lay himself open to the charge of making security an object of policy, but it involves constructive measures designed to assist the non-Prussian German States to settle down to peaceful activities and abandon their world-conquering ambitions, and to work out a satisfactory existence. Moreover, he frankly recognizes what is often forgotten, as Prof. Carr reminds us, that no durable peace can be made unless those who have the power have also the will, in the last resort, after having tried all methods of persuasion, to take and enforce with vigour and impartiality the decisions which they think right.

Equally it is important that those who have the power should recognize the moral obligation which alone makes its exercise tolerable to others. This vital truth appears to be overlooked by Dr. Einzig in urging a declaration in favour of a hard peace. That may well have its place in the moral offensive which others besides Prof. Carr have stressed, notably Mr. J. F. Dulles in the American periodical *Fortune*. The importance of propaganda has been overlooked in our war effort, and Dr. Einzig is on sure ground in directing attention to the value of an emphatic assurance to the conquered peoples that after British victory they would not be left at Germany's mercy. That assurance need not be based on the motive of hate which Dr. Einzig inclines to suggest in his account of the mistakes of appeasement. It must be based on the quiet, dispassionate analysis which Prof. Carr gives us.

It is encouraging to find how much of this admirable analysis finds a counterpart in Mr. Dulles's stimulating article. Very clearly, thought in the United States is moving on similar lines, and opinion there is indeed more, rather than less, likely to support a hard peace than in Great Britain. The keenness of Mr. Dulles's analysis of the Atlantic Charter and his insistence on realistic thinking and on the need for a change in outlook and for real political education should be carefully noted. If the conditions of peace sketched out by Prof. Carr are to materialize, with all the implications they connote, scientific workers must make their own contribution. They have a part to play in the political education required and in carrying into the political field the spirit and method of science. The readiness to accept change and the forward-looking mind are part of their own tradition; the Anglo-American co-operation in science already being forged as part of our war effort may well be extended to lay the foundations of a true science of politics and of international relations, without which the evolution of world order must remain visionary. Even among the great democracies, politics was, and still is, too much at the mercy of prejudices and catch-phrases. War-time parliamentary elections in Great Britain have shown the dissatisfaction of electorates still approached in the old fashioned way. With the spread of adult education, and with the growth of understanding, of themselves and of each other, of the English-speaking peoples and active co-operation with the U.S.S.R. which war-time needs have made imperative, the development of political science on a world-wide basis has become a possibility which cannot fail to leave its mark on the history of civilization.

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* Appeasement Before, During and After the War. By Paul Einzig. Pp. xii+216. (London: Macmillan and Co., Ltd., 1941.) 10*s.* 6*d.* net.

EDUCATION AND TRAINING OF ENGINEERS

FOR some time past the Government, industry and the teaching institutions have been working in common towards the creation of a body of skilled engineering personnel in Great Britain adequate to meet the enormous productive and operational needs of the war machine. Much of the system which has evolved, and is still evolving, will be unsuited to a long-term peace-time policy, but the contrast with pre-war procedure has emphasized the need for reconsideration of the whole plan of technical education and training. It is at once evident that the problems involved will not be solved by individual effort, however well conceived, of particular sections either of industry or educational authority. Each has a vital part to play, but it is essential that the separate efforts be linked together intimately in a national plan, and it is gratifying to observe that steps are already being taken in this direction.

The result of a preliminary consideration of the problem by the Education, Training and Personnel Sub-Committee set up some months ago by the Post-War Planning Committee of the Institution of Electrical Engineers was presented in the form of a paper read by its chairman, Dr. A. P. M. Fleming, before the Institution on March 19. The paper opens by emphasizing the need for a broader conception of the aims of technical education on the part of both the educational institutions and of industry, and by quoting the Adult Education Committee of the Ministry of Reconstruction of 1919 as follows:

"Technical education has only too often defeated its own object by the narrowness with which it has been conceived and carried out. . . . Technical efficiency is primarily dependent on qualities requiring for their growth opportunities for expression which cannot be adequately provided within the range of purely technical studies."

That this expression of opinion was no less appropriate in 1939 was due in large measure to the fact that industry, taken as a whole, had failed to accept adequate responsibility not only for the effective practical training of its employees but also for their part-time day release for technical instruction. Th latter made necessary a general adherence to th system of evening-class instruction, a system whic not only restricts unduly the scope of the technica instruction possible but also leaves no time for th fostering of cultural interests, and imposes consider able strain on the physical well-being of the students It is shown that on the average during the 1936–3 period no more than 10–20 per cent of the boys wh entered upon the first year of National Certificat courses in engineering remained to enter the fift and final year, and that few of those who withdrew transferred to alternative, more practical, courses Of no less serious import, however, is the fact tha the evening courses provided failed—and mus inevitably fail—to stimulate the inclination fo independent reading and thinking, and tend t stultify rather than encourage the processes o critical analysis. The effect of these restriction was evident enough during the pre-war period ; it ha since been more serious.

The general replacement of evening technica instruction, in whole or in part, by part-time day instruction, with the evening periods then left free under careful guidance, for independent technica study and for the fostering of cultural interests, mus be regarded as an essential item in post-war planning Then, and only then, will it be possible for th technical colleges of Great Britain to attain thei full status as centres of adult education in th broadest sense.

To this end it will be necessary for the colleges t give much increased attention to the education o the craftsman as distinct from the technician. Th former, generally speaking, reach their highest leve of responsibility at the age of twenty-one or less and the problem of ensuring a healthy attitude o mind towards their employment and an improved utilization of leisure hours is a very real one. It solution will demand not only an effective presenta tion of the vital importance of craftsmanship in th national life, but also the raising of the status o craft instruction in the colleges and the improvemen of personal amenities for craft employment. It i suggested that a national apprenticeship scheme b introduced, sponsored by the Ministry of Labour, a the co-ordinating body for industrial concerns, an the Board of Education, acting similarly for the loca education authorities. On the one hand, this woul require the provision throughout industry of organize courses of practical training, involving possibly th creation of special apprentice workshops and th use of the now well-established Ministry of Labou training centres ; and on the other, extended course of instruction in manual processes leading to suc aspects of workshop administration as fall within th responsibility of foremen, inspectors, rate fixers an the like.

The scope and difficulty of the whole problem o educating and training engineers, and indeed a technical personnel, has increased, and will continu to increase, with the rapid expansion of scientifi knowledge and technical development, and with th necessity which these impose of increased specializa tion for the technician and of change from craft to highly mechanized conditions of employment for the artisan. Too much stress cannot be laid on the need in all cases for ensuring an adequate foundation of general education to the appropriate level prior to specialization, and a full appreciation of the purpose of the significant specialized activity in relation to the life and welfare of industry and the community.

A special responsibility in this respect falls on the universities. It is suggested that there are two vitally important needs of industry in Great Britain which it should be the function of the universities to satisfy. One is for men capable of interpreting scientific progress in relation to industrial possibilities and of applying scientific methods of analysis to the problems which arise in each progressive stage of technical development. The other is for men who combine with adequate scientific and technical knowledge the personal qualities and power of leadership specially necessary on the productive and administrative sides of industrial organization. At the present time, the engineering schools tend to treat all students as though they are destined for high-grade scientific or technical work. Those who are—and indeed all—will be better for a broader scientific foundation, less specialization and fuller opportunity to take part in the corporate life of the university. Those who are not—and in an average year the proportion is high—should be permitted to replace the more advanced stages of the mathematical and technical work by studies in such subjects as the social sciences and economics.

To this educational preparation must then be added the practical and essentially technological parts of the training, and in neither respect are the present provisions satisfactory. Many large firms still make no provision for the systematic practical training of their graduate recruits, while those who do pay too little attention to the efficiency, or inefficiency, of the process by which the graduate acquires the information and experience to be gained. In keeping with Sir Richard Livingstone's views, it is suggested that all prospective university engineering students should be required to spend one year in industry between leaving school and entering the university. So long as reasonable continuance of scientific and mathematical study is ensured, and that satisfactory provisions are made within industry for the practical instruction of the boys concerned, this arrangement would be advantageous in every way. It would seem to offer the most effective means of self and guided selection, and the opportunity it would afford for mental adjustment is of the greatest importance.

At the post-graduate stage the continued practical training, leading, after the appropriate period, to the choice of, and concentration on, a particular branch of engineering work, requires to be supplemented in a much more effective manner than has been the case with systematic technological instruction. The amount of information and accumulated experience which a man must acquire before he can hope—or be expected—to make an original contribution to development is often so great that its acquisition purely by independent effort may be an extremely inefficient process. In recognition of this, a few firms have provided suitable lecture courses and afforded opportunities for discussion as an integral part of their training schemes. The disadvantage of this arrangement is that access is limited, and there is great need for supplementary provisions in the local colleges and universities similar to those instituted in the Manchester area in 1937 under the auspices of the regional advisory committee responsible for co-ordinating technical and other forms of further education. The circular announcing the first series of advanced lecture courses stated: "It is probable that there are many engineers engaged in the highly differentiated engineering industry of the region who would be attracted by courses of lectures dealing with specialized problems related to their daily work. If these lectures were given by specialists in intimate relation with the practical problems of industry, if they attracted engineers who, in their professional capacity, were directly concerned with the subject-matter of the courses, and if the lectures were informal and provocative of discussion, it is believed that they would constitute a useful innovation in engineering education in the region." This scheme offered no attractions in the form of certificates and afforded no artificial examination stimulus to the acquisition of knowledge. Its operation was temporarily discontinued in 1939, but the success and extension of this type of scheme is a matter of considerable educational interest and importance.

The report submitted by the Sub-Committee of the Institute of Electrical Engineers concluded with a discussion of the short-term problems of education and training which will arise in the immediate post-war period. The drafting into industry of men now with the Fighting Services and in Service establishments will present many difficulties; special provisions will have to be made in industry and the educational institutions to cater for the diversity of needs of both industry and the men concerned. Government grants will be required to cover the expenses of the training period. It is emphasized that these should not become the prerogative of ex-officers only, but should be available to all men with the necessary qualifications, experience and promise—a principle which has already been established in the recently instituted scheme of State bursaries. With the view of preparing the ground, the Committee intends to collect data concerning members of the Institution of Electrical Engineers now engaged with the Services and to make an assessment, so far as, and as soon as, is possible, of the probable personnel demands of the various branches of the electrical engineering industry and of the extent to which each firm can absorb, for purely training purposes, personnel outside its own requirements.

At a time of uncertainty like the present, little can perhaps be done in this direction, but it is beyond doubt that, having recognized past deficiencies, the whole of the engineering industry in Great Britain will support wholeheartedly any movement which has as its object the well-being and proficiency of its vast personnel.

CYTOPLASM OF THE PLANT CELL

The Cytoplasm of the Plant Cell

By Prof. Alexandre Guilliermond. Authorised translation from the unpublished French manuscript by Dr. Lenette Rogers Atkinson. (A new Series of Plant Science Books, Vol. 6.) Pp. x+247. (Waltham, Mass.: Chronica Botanica Co.; London: Williams Dawson and Sons, Ltd., 1941.) 4.75 dollars.

PROTOPLASM, the physical basis of life—to use Huxley's oft-quoted aphorism—is the very stuff of life, but its mystery lies not merely in its composition but even more in its organization. The correlation between the structure and behaviour of the nucleus and the demonstrable facts of heredity is one of the outstanding achievements of modern science. Possibly for this reason the study of the cytology of the cytoplasm has suffered in comparison with the cytology of the nucleus. Particular interest is attached, therefore, to this book by Prof. Alexandre Guilliermond, professor of botany in the Sorbonne.

Written by a pioneer investigator, the work is the most complete account in English of the contributions to our knowledge of the cytoplasmic inclusions which have been made by the French school of cytologists of which Prof. Guilliermond has been the leader. Translated from an unpublished manuscript in French, the book is vol. 6 of a new series of plant science text-books published by the Chronica Botanica Company and it contains a foreword by Prof. William Seifriz, who is also a notable contributor to knowledge of plant protoplasm.

The cytology of the cytoplasm and of the nucleus must be approached in different ways. These differences lie not only in the laboratory methods, though Prof. Guilliermond has much to say on this subject. The nuclear cytologist deals with what is usually the largest of the cellular inclusions and yet by his technique he often paints miniatures, although they are often exquisite in detail and definition. Though he may investigate the most minute living inclusions known in plant cells, the cytoplasmic cytologist must allow his attention and vision to roam over the entire range of a varied cytoplasmic 'landscape' and must portray—as in a swiftly executed water-colour—the ever-changing cytoplasmic scene. Understanding and appreciation of Prof. Guilliermond's eminently readable account will grow as the reader recognizes and accepts that the cytological problems of the cytoplasm have, of necessity, been approached by distinctive methods.

To the student of cell physiology the work is of the greatest interest. Much of physiology has been dominated by the desire to explain vital processes in terms of the accepted principles of physics and chemistry deduced from observations *in vitro*, and too often too little attention is paid to the milieu in which they occur *in vivo*. Plastids and vacuoles are two of the inclusions of great interest to the student of metabolism concerning which cytology has hitherto had but little to say. Plastids as living inclusions in the cytoplasm are intimately concerned with carbohydrate metabolism; vacuoles are usually recognized as liquid inclusions in the cytoplasm, characteristically able to accumulate salts and solutes and are regulated in this behaviour by the vital processes of the cells. Full understanding of photosynthesis and of mineral nutrition awaits a complete knowledge of the part which these inclusions play: Prof. Guilliermond's account of their morphology and development is a contribution to this end.

It is inappropriate to anticipate the conclusions which only emerge as one follows Prof. Guilliermond in his skilful path through the maze of mitochondria, chondriosomes, chondrioconcts, plastids and the thread-like, colloidal progenitors of vacuoles. In Prof. Guilliermond's view the chondriome of green plants consists of two types of inclusion which are not always distinguishable on morphological grounds but which, nevertheless, preserve their identity throughout the development of the cells. Of these, one type is characterized by its greater ability to elaborate carbohydrates and develops into plastids, whereas the other type remains minute and its members are regarded provisionally as "inactive chondriosomes". Plastids only have the "chondriosomal form" in their inactive phases and it now appears that their subsequent change in form may be reversible. Prof. Guilliermond takes frequent occasion to remark, with apparent justification, that one must be suspicious of analogies in shape for inclusions as different, as young vacuoles and the thread- or rod-like chondrioconcts may, at certain stages, be similar: in such cases the evidence of chemical composition or of development is marshalled to determine their identity.

A multiplicity of terms may be inevitable in so descriptive a subject but some may feel that this has gone to excess. "Gliode" to denote a colloidal system only to be found in living cells is a case in point. Furthermore, some well-established terms are not used in their precise technical sense. For example, 'crystalloid' is used as though synonymous with 'crystal' and the terminology used to describe colloidal systems seems unnecessarily involved and unfamiliar. The terminology of fats and fatty substances of complex composition has for long been a frequent source of confusion. Many would no doubt prefer 'lipoid' to 'lipide' to denote substances with the solubility and other general properties of fats, while "gluceride", on p. 26, seems an obvious misprint for 'glyceride'. Lecithin-like substances for which the term lipines is often used are somewhat elaborately termed 'phosphoaminolipides', and their identification as the chief components of minute inclusions in the cell is described: this identification, based on microchemical tests alone, may appear too sanguine to the critical biochemist.

For the most part the style is admirably concise and vivid—especially in the morphological descriptions. However, even brevity may be carried to extremes and some of the descriptions of the physico-chemical characteristics of cells are for this reason meaningless: this is the case in the following passages: "The ratio cholesterol : fatty acid, or the lipocytic coefficient, is characteristic of a given species. It constitutes a cellular constant. There also exists a mineral constant. Similarly the water content for each type of tissue always fluctuates about the same value, therefore each type of tissue in a species possesses a constant and specific content of water of imbibition. Water is thus a cellular constant." Nevertheless, physiologists should not be deterred by this cursory treatment of these aspects of cell physiology from reading the rest of the book.

A historical point arises in connexion with the vacuole. De Vries is credited with the discovery of plasmolysis. Most authorities credit de Vries with the first use of the term, but the first observation of the process is usually attributed to Nägeli in 1855.

Prof. Guilliermond's book was published in 1941. English readers will be gratified that this new account of so much French cytological work could be published in the United States despite the collapse of France. The preface states that Dr. J. Dufrenoy, who is well known to many English and American botanists and who was at one time an associate of Prof. Guilliermond, is now in the United States and assisted with the preparation of the book for the press. May we express the hope that a free interchange of ideas between the botanists of England and France may soon return, meanwhile English readers will welcome the latest summary in English of the work of French cytologists on the cytoplasm of plant cells. F. C. Steward.

ANALYSIS OF MODERN STEELS

The Chemical Analysis of Ferrous Alloys and Foundry Materials

Modern Practice and Theory. By E. C. Pigott. Pp. xv+362. (London: Chapman and Hall, Ltd., 1942.) 28*s*. net.

The increasing use of alloy steels has produced difficulties necessitating modifications in the methods used in the analysis of plain carbon steels described in the older text-books; and in addition, considerable research has been required in order to simplify the estimation of the various additions, which now include many of the less common elements. The author, in the volume under review, has attempted to remedy the deficiency.

The scheme of the book is conceived on somewhat original lines. Each element is treated separately, and after describing its chemical and physical properties, and its role in steel manufacture, a consideration of the methods of analysis is given. This is followed by complete directions. An admirable feature is a very useful section dealing with the chemistry involved. This section, in particular, makes clear to beginners the fundamental principles underlying the various methods. This is too frequently disregarded in text-books of analysis. Many of the sections give evidence of careful investigation of various methods, more particularly those in which disputes are frequent. The chapter on the estimation of aluminium may be cited as an example; no reference is made, however, to the method in which most of the metals are removed by electrolysis using a mercury cathode.

The book also contains sections on the analysis of aluminium alloys, copper alloys and refractories. In none of these has the author been so successful. In the section on the analysis of aluminium alloys, it is perhaps incorrectly assumed that all the zinc is extracted by treatment with caustic soda. The silica estimation must also be made in nickel or platinum vessels, and not porcelain, since the attack by strong soda is by no means negligible. The estimation of iron and aluminium in copper alloys by precipitation with ammonia would also lead to high results for the latter element, due to the presence of zinc, if only one precipitation is made.

The method suggested for the analysis of refractories is in many respects open to criticism. The ignition of alumina requires a temperature of at least 1,100° C. and not 900° C. as specified. The single precipitation of magnesium as phosphate in the presence of such an excessive amount of sodium salts must lead to an erroneous result.

There are few adverse criticisms to make on the other portions of the book. The photograph of the carbon apparatus, however, is not marked with the letters used in the description, with the result the details are difficult to follow. In a future edition, the table on p. 345 could be extended with advantage by giving suggested methods for various types of steel.

The author has produced a most useful treatise which should prove of great assistance to all analysts who are already experienced in the methods of analysis of the older steels.

CHEMISTRY IN CLINICAL MEDICINE

Manual of Clinical Chemistry

By Miriam Reiner. Pp. xv+296. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1941.) 3 dollars; 18*s*. net.

Methods of precision play an important part in modern medicine: they constantly seek, by the plain accuracy of scientific statement, to clarify clinical findings, to reinforce judgment, and to place opinion on a stable basis. Their proved value, proved by the work of an older generation, has broadened and amplified their place and scope, growth rapidly pushing forward with each new and accepted success. The present generation has in the physical, such as X-rays, and the chemical, such as the numerous tests whereby the intimate functions of the body metabolism can be observed, become familiar with new weapons which are now as much clinical necessities as a thermometer or a stethoscope. So far the field of value of such measures remains largely diagnostic and prognostic; the therapeutic application, without decrying the place of the exact control observations possible in many diseases, still rather lags behind.

Miss Reiner's little volume on the technique of the many chemical methods in everyday use comes from the Mount Sinai Hospital, New York, and certainly fulfils the standard which would be expected from a product of that institution. The book is first of all a manual, that is to say, it is a volume compact in make-up, but bold in print; systematic in arrangement but complete in adjuvant details; and of a size convenient to be propped up on a laboratory desk or thrust into a peripatetic pocket. The whole subject is fully, indeed generously, covered, ranging from specifications, indicators and measures to tests for the common poisons, vitamins and hormones. Adequate and proportionate space is given to the various function tests, gastric analyses, urine and cerebro-spinal fluid examinations, etc., the section on blood analysis being—and rightly so—the largest.

The method of statement of the procedure to be followed gives to each step of detail its corresponding line, thus gaining on one hand clarity of presentment and on the other being practical and time-saving. It is pleasing to note an insistence on exactitude of measures and times and on the technical details of the preparation of reagents.

Miss Reiner's book is obviously intended for an American audience and suffers, therefore, in trivial details in presentation to a British. With this slight reservation, the book can be cordially commended as a competent and careful piece of work fulfilling in every sense its aim. The bibliography has been wisely cut down to one or two references pertinent to each item. Joseph Geoghegan.

Practical Mathematics

By Clement V. Durell. Pp. viii+176+xv. (London: G. Bell and Sons, Ltd., 1942.) 3*s.* 3*d.*

THE intensive study of the principles of elementary mathematics has greatly increased with the coming of war and, as a consequence, a new type of book has made its appearance. The necessity of this lies in the fact that, in preparing for the technical branches of the Services, students have little time to study several comprehensive text-books. What they need is a single volume containing the essential arithmetic, algebra, geometry, trigonometry and mechanics, dealt with as tersely as possible and with a practical bias.

Mr. Durell's book meets these requirements and, as would be expected from this author, the treatment is lucid and the subject-matter well presented. The ten chapters amply provide the basic mathematical equipment needed by the students for whose use the book is especially intended. A larger space than usual—some twenty pages—has been devoted to tables but, in view of their value to practical students, it is somewhat surprising to find that tables of anti-logarithms have been omitted.

Elementary Qualitative Analysis

For College Students. By Prof. J. H. Reedy. (International Chemical Series.) Third edition. Pp. x+156. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 10*s.* 6*d.*

THE fact that a third edition of this American manual on elementary qualitative analysis has been issued indicates the undiminished confidence and popularity in which this book is held in the United States. Moreover, it can be confidently recommended to teachers and students in Great Britain as a satisfactory work on qualitative analysis up to intermediate standard.

The book follows the conventional system of analysis for the common metals and acid radicals, but new methods and modifications of older methods have been included in certain cases as time-saving and reliable measures. The use of the centrifuge for facilitating the rapid separation of precipitates is of interest and might be more widely adopted. In addition to instructive details, the manual includes numerous exercises and questions, and is generally written in a style which will stimulate and hold the interest of a student starting on chemical analysis. The price, however, is likely to be too high for most students.

A New Scheme of Elementary Qualitative Analysis

By A. J. Mee. (Dent's Modern Science Series.) Pp. x+52. (London: J. M. Dent and Sons, Ltd., 1942.) 1*s.* 9*d.*

ANY departure from the well-trodden paths of elementary qualitative analysis is a sufficiently novel event to stimulate the interest of all chemists engaged in the teaching or practice of chemical analysis. In this little volume, Dr. Mee describes a new workable scheme for the detection and separation of the common metals, the principal feature lying in the fact that hydrogen sulphide gas is not required in the analytical separations. The poisonous nature and the difficulty of providing adequate supplies of hydrogen sulphide provide an additional recommendation for these new methods, which do not require any reagents not part of the normal stock of a chemical laboratory. For confirmatory tests with certain metals, however, special reagents are advocated, but the detection of acid radicals follows conventional lines.

The scope of this book broadly covers the requirements of students in qualitative analysis to intermediate standard. Teachers of chemistry are advised to obtain a copy of this book which is very moderate in price, and read it carefully; if there is something to criticize, there is also much to interest and stimulate.

Intermediate Quantitative Analysis

By Dr. A. J. E. Welch. Pp. iv+128. (London: University Tutorial Press, Ltd., 1941.) 3*s.* 6*d.*

THE small volume under review provides a course of practical exercises in quantitative chemical analysis up to intermediate and Higher School Certificate standard. Since the book is essentially designed to meet the requirements of examining bodies, the emphasis is largely on volumetric analysis, where the use of equivalents and normalities is strongly advocated. There is also a short but adequate section on gravimetric analysis, and many problems and exercises are to be found throughout the text. The book is very moderate in price and can be recommended as a worthy successor to "Elementary Quantitative Analysis" by Briggs and Bausor, which it now replaces in the University Tutorial Press series of text-books.

World Revolution and the Future of the West

By Dr. W. Friedmann. (Thinker's Library, No. 88.) Pp. x+118. (London: Watts and Co., Ltd., 1942.) 2*s.* net.

DR. FRIEDMANN, from an originally German and juristic standard, forecasts the fashion in which the present horrible chaos came upon us, and how the direct values should be secured. He is rightly concerned primarily and mainly with Western civilization. The globe has been humanized from the West, the Greco-Romans leaving their human structure to survive the revolutions which have led us to the present. Humanity, imperfectly indeed, passed the consolidatory Roman stage crowned by the glory of Greece. Then a further socializing covers the same ground in Christianity. Without the survival of these three—law, reason, beauty—humanity would not have come to the birth: laid as they have been in fresh revolutions to the present.

The legacy ensures the survival of socialization and lends itself from time to time to quiet lapses, as the eighteenth century, or scientific marvels, from the eighteenth century onwards. The British Empire has served and should still serve as the umbrella: one supposes that with the United States, an ultimate guarantee can be secured.

The main theme of Dr. Friedmann is what he calls the totalization of the West. He describes the methods by which, as in England, the desired advance is secured without conflict. The present crisis takes the form of securing to every individual sufficient to his needs spiritual as well as physical. One is bound to say that the standard of the spiritual is deplorably lowered on the way. The agency of a B.B.C. plants standards of taste far below what would be enjoyed if it continues to enforce the same with damnable iteration. There is a plain duty to lead upward.

It is pleasant to see that Dr. Friedmann, though obviously a communist in theory, lays the greatest stress on preserving as much freedom as consistent with the social fabric holding together. But a brave man will hesitate on prophecies in detail. The world conflict has still to be completed. F. S. MARVIN.

SOCIAL STRATIFICATION IN BRITISH SOCIETY

AT the extended general meeting of the British Psychological Society held at the Municipal Training College, Brighton, during April 9–12, the Section of Social Psychology arranged a symposium, under the chairmanship of Prof. M. Ginsberg, on the theme of "Social Stratification".

Prof. T. H. Pear, professor of psychology in the University of Manchester, read a paper on "Psychological Aspects of English Social Stratification". He began by pointing out that sociologists approach the subject of social stratification by making general statements about classes, comparing and contrasting them, but with very few illustrations from actual instances or research studies. This sort of specific information is regarded as rather a matter for journalists or novelists; but journalists and novelists are often biased by selection and personal preferences. Perhaps the roots of the difficulty lie deeper. Is it part of the general tendency of sociologists to eschew the concrete case—to be nomothetic instead of epigraphic ? Anyone who ventures into this area of psychology puts himself in a position to be shot at from both sides simultaneously. The subject of the symposium, therefore, is almost untouched by psychologists and attracts surprisingly little attention from sociologists. There are social forces which make it difficult for a professional thinker to regard his own position in society objectively, and fully to comprehend its meaning in a wider social pattern. Severe taboos are imposed upon detailed consideration of social status (especially of persons living in any but the 'top' and 'bottom' layers of society). This unanalysed acceptance of social status ('knowing one's place') partly explains the sociologist's and psychologist's neglect of social stratification. So English social psychology is, on the whole, an account by middle-class writers of middle-class behaviour.

English social stratification is not what it was in 1939 and it will change considerably when peace comes, according to Prof. Pear. It is, however, necessary to record that as in Disraeli's time there are still two Englands. From many directions we hear that after the War there will be great changes in the English social classes. In one sense this is a platitude. All modern wars cause social change; this is what they are fought for. Social stratification will be less, and the lines of demarcation less clear. At the beginning of this War, some urged that it should be fought for the 'English way of life', describing it in a manner which might be recognized by their friends, if not by the majority of the English. Since then, many have pointed out that no national way of life ever completely survives a great war; relatively few could wish our social structure to be exactly restored—cracks, moss, mildew and all.

Prof. Pear then went on to discuss social differences as shown by language. Each class uses characteristic terms of approval, disapproval, endearment, enthusiasm and boredom, and each disapproves or ridicules the choice of others. Euphemisms, too, are class-labels. Perhaps most of these are used by the middle (especially the lower-middle) class. Of the learnt phrases which especially indicate social strata the emollient group are the most striking. A good diplomat has many in stock, and knows when to produce the right one. They are used to begin, interrupt or end a conversation, to refuse or decline a request, suggestion or invitation; to correct a misstatement, to oppose a proposition without rancour, to adduce incontrovertible if unwelcome evidence, to accost a stranger, encourage a shy person or reprove a backslider. One social group may inaccurately attribute 'bad' speech to another. American journalists, when they 'quote' English working-class speech, are apt to write it without aspirates, yet in many parts of industrial England the 'h' is seldom dropped. With such warnings in mind, it may be said that difference in vowel-pronunciation is an important mark of social class. The Cockney modifies all the English vowels, usually transforming them into diphthongs. The auditory 'aspect' of speech is perhaps more important than the visual accompaniment, facial expression, gesture and posture. The comparative absence of facial expression and gesture from the speech-behaviour of the English 'ruling classes' may be a sign of social stratification.

On reading attempts made between 1918 and 1939 to explain war in terms of human experience and behaviour, Prof. Pear has been driven to conclude that most of them were conceived from an upper-class point of view. Underlying them is the assumption that when war is declared the author will take —or be holding—a commission. Few, especially those who 'explain' the stirring up of war in peace-time as due to aggressiveness, ask themselves how much the poorer people know about the nations for whom, after war has broken out, they are exhorted to feel emotions specified by the propagandists. In the past, privilege may have exercised good influences in many directions, yet during our lifetime its shortcomings have been increasingly obvious. To-day it seems to be falling into disfavour all over the world. Yet the difference ought to be clearly recognized between lessening privilege and decreasing tolerance of individual differences. Prof. Pear urged social psychologists to study social phenomena, both in the upper and the lower classes. For gentle manners are not the result of an accident, and he feels it would be a tragedy if we lost them.

Mr. Tom Harrisson, of Mass Observation, contributed to the symposium a paper on "Class Consciousness and Class Unconsciousness". There is no doubt that there are differences between different groups of the community, but after spending five years in making Mass-Observation studies of ordinary people in all parts of the country, he feels the extent of class difference has been exaggerated. Some sections of the community are richer or poorer, more or less educated, but the conception of clearly divided self-conscious groups is of doubtful validity. The class who are really 'class conscious' are the small upper-class group, who feel deeply aware of the mass of poorer and less educated people 'below' them, and often fear them. Many of the characteristics of 1942 Britain are due to this underlying 'fear of the masses' among our leaders, and their consequent tendency to treat working people as if they are somehow stupid and dangerous, to be kept in good humour but also to be kept in place. Among much the largest section of the community—the manual workers—there is little class consciousness; there are many divisions within the working class, as regards mentality and outlook. There are marked differences and conflicts, for example, within a cotton mill, and even within the team of three working on one cotton operation—the spinner, the side piecer and the little piecer.

This is not to say that there are not big differences between different sections of the community. But these differences are not necessarily *class* differences; there are often much bigger age or sex or temperament differences on the same subject. In general, the basic distinction is the amount of money owned or earned, and connected with this the degree of education. In observational studies of non-voting, over a series of municipal elections in which there were candidates of 'middle-class' and 'working-class' parties, it was found that 38 per cent of the so-called upper-class did not vote, 42 per cent of middle-class and 48 per cent of working-class. In a recent investigation on political attitudes, it was found that while most middle-class people were, for example, able to name at least one living Liberal politician, the majority of working people could not name one at all. Again, the degree to which people hold an opinion on propaganda films decreases sharply as one descends the economic scale. Many other examples could be given from Mass-Observation's researches, said Mr. Harrisson, to illustrate differences of knowledge and reaction between those who ended their education at the elementary stage and the better-off minorities. Cash differences inevitably produce other differences. But to term these indiscriminately 'class differences' obscures the fact that there are probably few inherent differences within the individual which cannot be eradicated in various ways, often quickly.

Mr. Harrisson thinks that the mental gulf between the upper classes and the working classes has been gradually exaggerated in the minds especially of the upper classes, though this does not make it any less significant psychologically for them. We have seen lately, in the rapid growth of works councils in war industry, how much can be done in a factory simply by bringing together around a table once a month some representative workers and managers. In the past most firms have assumed that the distinction between management and worker is absolute and essential; in war this distinction is found to be obstructive to maximum effort, and it has now been proved to be (to a considerable extent) avoidable.

Mr. Harrisson considered that the most useful symbol of British social structure is the familiar pyramid, with the King on the top, the mass of £3-a-week people at the base. There is a constant tendency among those at the bottom to try to climb up towards the top. The general tendency is to admire those at the top, seldom to resent them.

Mr. Harrisson described some ways in which working people in "Worktown" canalize our culture urge to go up the social scale. Every week-end Worktowners spend an extra quantity of money in special pleasures, such as drinking beer in the public lounge, where the *same* beer costs 1*d*. more than it does in the 'vault', used on week-days. During the week anybody wearing a bowler hat is either middle-class or a mourner. At the week-end, anybody and everybody may wear a bowler and look thoroughly middle-class. The week-end cycle is a regular process of class elevation, and men who never think of wearing a tie during the week may have a gold tie-pin on Sunday. Secondly, there is the cycle of the year, for which people save up every week, to take one week's holiday at Blackpool or elsewhere, generally at a much higher level of expenditure, environment and social prestige than they have ever enjoyed in their home town. One week a year they are able to live on a higher rung of the ladder.

Thirdly, there is the cycle of life. Many working people put aside money every week in their lives so that they can be buried with rich pomp and ceremony at their deaths. Moreover, the graves in Worktown cemetery are graded into four classes, according to the distances from the path and therefore the number of people who see your tombstone. Class I is very expensive and beside the main path. It is the ambition of many poor people to have in death a class position unattainable in life.

Prof. J. C. Flugel, assistant professor of psychology in University College, London, read a paper in the symposium on "Class Mind and Group Mind". He agreed with much of what Mr. Tom Harrisson had said. But we are forced to use the term 'class' because there is no better one available at present; in using it we must constantly remember that class is nothing rigid, but something very fluid. Psychologists have not tried to investigate the problem of class-consciousness systematically, though there has been a certain amount of work on racial and other attitudes. One is sometimes inclined to believe that the term 'class', as H. G. Wells remarks, has degenerated into a mere weapon or term of abuse. Class may be fixed by a class hierarchy, but otherwise it is difficult or impossible to define. Class fulfils only partly the criteria of McDougall's "highly organized group", that is: a group with a common purpose, continuity, some adequate idea of itself, interaction or rivalry with other groups, a body of common traditions, internal organization of the group, including specialization and differentiation. Marxism aims at bringing about an accentuation of these criteria, especially a common purpose, an adequate idea of the class grouping, and interactional rivalry. It assumes that there are only two classes and there will be an increasing dichotomy. In this Marxism has proved to be wrong, said Prof. Flugel; not only has 'class' become increasingly continuous, but also class distinctions are cut across by numerous other groups, the boundaries of which are drawn on other lines. Many workers are now small-scale capitalists; many in the general election of 1931 had the capitalist side of their feelings (fear about savings, etc.) accentuated so much that it swamped the workers' side (Labour sympathies, etc.).

Prof. Flugel felt that class distinctions are becoming more confused, rather than less, and that Marx's brilliant theory has not worked out in practice in Great Britain. Employers have increasingly sought to cultivate new loyalties within classes by profit sharing, bonus systems, welfare schemes, and so on. Then there is the rise of the manager in all his different grades; the increase of minor bureaucrats and officials; the small business man running his own business or shop, who may be more of a property owner than the salaried manager, but inferior in wealth to the skilled worker; such people feel interest in the nature of their business rather than their class.

Prof. Flugel went on to point out some changes in social stratification. A new sense of interest in and guilt about the conditions of the poor has occurred in the upper classes, and increasingly within the past few years. The realization of this responsibility is largely due to the rise of Socialism, but is also in opposition to Socialism. Then, working people have become more conscious of their increased opportunity to rise in the social ladder, though it is still limited. Workers want to belong to the upper class, rather than to destroy it.

Some connexions between social stratification and Freudian theory were finally suggested by Prof. Flugel. The upper class group compare, from the workers' point of view, with the 'ego-ideal'. This would explain to some extent three contradictory attitudes towards the upper class—the attitude of wanting to rebel against it, the attitude of wanting to attain it, and the attitude of wanting to submit to it. On the other hand, pure class-consciousness in the Marxist sense stresses only companionship in a continuation of the sibling relationship, the 'id'. But we also need the child-adult (parent) relationship, the 'super-ego'. Now all revolutions towards one class lead to dictatorships, and these are thereby socially unstable. A revolutionary movement can scarcely be as morally satisfying as a 'patriotic' movement.

Summing up, Prof. Ginsberg said that he felt the Marxist point of view, which he by no means wholly accepts, had been rather underestimated in discussion and that there are aspects of it which still throw light on present conditions. There is a certain reality in 'class', in so far as 'you feel at home' with somebody of your own class. There is much else that can be said; what is needed now is more thoughtful study.

ANIMAL HUSBANDRY IN INDIA*

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IT would be quite impossible to gain a clear idea of the complexity of the problems facing animal husbandry in India without some understanding of the special factors conditioning the subject in India. For example : (1) Religious and traditional prejudices and customs. (2) Effect of the density of the population and the low purchasing power of the cultivators on farming practice. (3) General lack of appreciation of the fundamental principles which underlie proper breeding, feeding and management, and the great need which exists for a properly balanced system of land utilization. (4) Lack in most Provinces and States of any expert animal husbandry organization devoted solely to the interests of livestock. (5) Annual droving of millions of dealers' cattle from north to south of India.

Slaughter. The cow is a semi-sacred animal and must not be slaughtered. In strict Hindu communities, it is not permissible to give a merciful release even to a fatally injured and suffering animal. These inhibitions are productive of the most far-reaching difficulties and make it impracticable to carry on dairying or stock breeding on strictly commercial lines.

Castration. Until comparatively recently, stock owners were unwilling to castrate their cattle at an early age, though the males and females run together on village grazing grounds. This objection is now being overcome, and castration of inferior animals is carried out on a large scale by Provincial veterinary departments. It cannot, however, be too much or too often emphasized that no lasting progress can be expected in livestock improvement until arrangements are made for controlled mating, and for the proper feeding and management of breeding females and young stock.

Grazing areas. Though highly desirable, the improvement of such grazing areas as remain is not a solution of the cattle-feeding problem. The best of these areas tend to be taken up for cultivation, and in any event, cultivators ought to aim at devoting a portion of their holdings to fodder crop production ; thereby producing better stock and more milk, and helping to maintain the fertility and physical condition of the soil. Without such a change of system —where necessary—progressive degeneration of cattle seems certain to follow the gradual disappearance of good grazing lands on which the better cattle are at present bred.

Pinjrapoles and Gaushalas. The semi-religious pinjrapoles and gaushalas which are maintained in most cities throughout India have in many cases become anything but the homes of rest and comfort for derelict animals they are intended to be. By arranging for competent management and by breeding from the best of the cows and selling their milk, it has been shown that conditions can be greatly improved and profits made. Further, by taking up land for cultivation outside the city, the extra funds thus obtained can be utilized, to great advantage, to provide fodder crops and grazing for the hopelessly derelict and for the better feeding of the milking herd and young stock. By using selected sires, valuable young bulls were also produced, which should be of considerable value to breeders in the vicinity. These institutions could thus be made valuable demonstration centres all over India, and in addition to their great educational value, would save large numbers of quite good milch cows which are committed to their care.

Density of population. Owing to the smallness of the holdings and the low purchasing power of the individual, it has generally been considered impracticable for the Indian ryot to produce fodder crops for the proper feeding of his cattle, or to produce or purchase the increased supplies of milk which are essential for the health and proper development of the people. The tendency has been to consider that the only practicable policy is to produce more and more crops for sale or direct human consumption. As a result, soil fertility and humus content have been greatly depleted in many areas and enormous damage is being done by denudation, owing to removal of cover and humus from the soil. There seems, however, to be no reason why, by a suitable system of mixed farming, the ryots in suitable areas should not obtain as great money returns as under the present system of devoting their entire holdings to crops and, in addition, better stock and an invaluable supply of milk and dairy products for their families. Experiments undertaken to test this view have in fact shown that by substituting mixed farming, including milk production, for the mere raising of crops for sale, agriculture in many parts of India could be raised to a higher level.

Dung burning and the manurial value of livestock. Throughout the drier parts of India the custom of burning cow dung for fuel is a serious handicap to agriculture. A great deal of manurial value is lost ; the soil is deprived of humus ; and, as cattle are not usually herded on the land due for cultivation, the manurial value of their urine is also lost.

Moreover, under the present system, village grazing grounds become so trodden and infected with disease that it is impossible to breed or maintain any but the most stunted stock on them.

In the absence of available firewood, the burning of cow dung seems bound to continue, but it is clear that more of the manurial value could be made available for crop production if cattle were better fed and maintained on the holdings, wherever possible.

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* Substance of a lecture before the India and Burma Section of the Royal Society of Arts, delivered on March 13.

Breeding practice and European cattle. Except among the expert breeders, who are dying out as the best of the grazing areas are taken up for arable cultivation, there is little tendency to ensure systematic mating to produce definite types, and one of the great dangers of importing European cattle into India is that the male cross-bred progeny are used indiscriminately as sires. It has now been shown that the better Indian breeds can easily be improved to a relatively high standard, by proper breeding, feeding and management. To control such work properly among the 200 million livestock of India, organized animal husbandry is, however, essential; thus it would take the place of these professional breeders. Otherwise sires of mixed or unknown parentage will be more and more used, though it is now well known that their progeny is very inferior.

Buffalo or cow. Much more highly fed as it usually is, the she-buffalo is generally considered to be a much more efficient milk and butter-fat producer than the cow, but a careful analysis of available data has shown that this is probably the case only where an abundance of coarse grazing is available. Indeed, strictly assessed in relation to the relatively high value in nutrition of the solids-not-fat of milk and with due regard to the need for a correctly balanced diet for the people, it is probable that for home production the balance would favour cows of the best Indian milch breeds. Under parallel conditions of feeding and management, such cows produce as much or more milk than buffaloes, and although the percentage of butter-fat is lower, the Zebu cow is highly efficient in converting dry crop residues into food of high biological value, and can even produce butter-fat as cheaply as the buffalo. For commercial dairying the buffalo has obvious advantages, but it is difficult to feel that the custom of maintaining she-buffaloes for milk production as well as cows for the production of working bullocks can be economically sound in rural areas.

Calf-rearing. In the case of buffaloes, the female calves are usually well fed and reared, while most of the males are allowed to succumb. In the case of cows the opposite happens, and in both cases it is the custom to present the stuffed hides to the cows at milking time to induce them to give their milk. In recent years it has been shown, however, that with proper handling when first brought into the milking herd, Indian cows yield their milk perfectly well without this, and that early maturity can readily be induced. It seems, therefore, that on agricultural holdings it would be sounder to use cows and feed them and both the male and female calves properly, instead of maintaining buffaloes as domestic milk producers and cows to provide the essential supply of work cattle. The custom of keeping cows in cities should also be discouraged, since it is insanitary and the cows—usually the best obtainable—are generally slaughtered at the end of the current lactation.

Dual- or single-purpose cattle. Judging from the limited success which expert breeders have obtained in Great Britain in their endeavours to produce cattle which are really efficient dual-purpose animals, for the production of milk and meat, it would probably be extremely difficult to produce breeds which would be efficient both for milk production and for the fast trotting or walking work which is the main purpose for which cattle are bred in India. With the rapid spread of motor transport the demand for fast trotting bullocks for road work is, moreover, rapidly decreasing, and with heavier ploughs it seems probable that slower moving cattle may in future be more acceptable to cultivators. A strong view is, however, held among them, from north to south of India, that capacity for fast work and high milk production do not go together. In any event, in view of the very striking improvement which has in recent years been effected in the milk yield, early maturity and docility of pure Indian dairy cattle, it seems certain that the best of these breeds will be developed to still higher levels. Milk recording and the publication of milk records has been undertaken by the Animal Husbandry Bureau to this end.

Annual droving of dealers' cattle. The droving of immense numbers of dealers' cattle from north to south and east to west of India involves constant danger of spreading contagious disease of all kinds, and protective inoculation of such cattle should so far as possible be enforced.

Animal husbandry departments. Embracing as it does about one third of the domesticated animals of the world, animal husbandry in India is obviously a huge undertaking, the development of which on modern lines requires much more extensive Government provision, independent of the requirements of cash crops, than has so far been made available.

It is not possible in the limited space at my disposal to discuss all the measures which were taken during my eight years as animal husbandry expert to place the various branches of animal husbandry in India on a better footing. From the first it was obvious that in view of the crippling losses from disease, malnutrition and similar causes, far more comprehensive Government expert assistance to stock owners was required. Every help was accordingly given by the Imperial Council of Agricultural Research to the reorganization of the Mukteswar Research Institute as (1) a research station in the hills, with staff and facilities for dealing in appropriate sections with all branches of veterinary research, and (2) a plains station for the production of biological products on the very large scale which is needed, and for research which can be satisfactorily carried out in the plains. The research staff at Mukteswar was organized in appropriate sections, each capable of dealing with a branch of veterinary research, and the substation at Izatnagar was provided with additional sections to deal with animal nutrition, poultry and poultry diseases, and genetics, in addition to the production of biological products. In this way a very comprehensive animal husbandry research and production institute was built up, and to provide the necessary link between research and the field work of Provincial veterinary departments, a veterinary investigation officer was also provided by the Imperial Council of Agricultural Research for each British Province and certain affiliated Indian States. These have been found of great value both to research and in the systematic study of local disease problems, and have now been made a permanent part of Provincial and State disease control organizations. Stockmen, capable of carrying out inoculation and first-aid treatment, after suitable training at veterinary hospitals, were also arranged for. The facilities for disease control and animal husbandry have thus been improved and research plans facilitated both at Mukteswar and at veterinary colleges, and during the past decade our knowledge of disease conditions and of the incidence of disease has been greatly increased.

The standard of veterinary education and technical training was improved at most veterinary colleges, and arrangements have recently been made to institute a B.Sc. university degree course at the Madras Veterinary College, in conjunction with the four-year veterinary graduates course. This is a welcome move in the direction of higher veterinary education, which is much needed in India.

Much attention was given to the improvement of dairying in India; this topic has been dealt with exhaustively by Dr. Norman Wright, who was brought out to give expert advice on the many and difficult problems which have to be faced by this industry under Indian conditions. Attention was also given to the control of disease among equines and to the improvement of local breeds of horses and donkeys; the breeding of horses was in the main provided for by a military organization, in the operations of which the Imperial Council of Agricultural Research had no say.

The nucleus of an Animal Husbandry Bureau was also formed and all the information available in the records of military dairies, dairy farms and similar institutions was extracted and published. By this means the great potentialities of pure-bred Indian cattle in regard to milk production was for the first time made generally known, and in combination with the publication of milk records, has acted as a great stimulus to the improvement of pure Indian milch breeds.

Authoritative definitions of the breed characteristics of several of the best-known breeds of Indian cattle were also taken up by the Bureau and have since been published; and a village survey was carried out, in four areas in different parts of India, with the view of ascertaining precisely the amount of milk and other dairy products produced and consumed by the Indian ryot.

A co-ordinated scheme for the improvement of the sheep of various parts of India was instituted by the Imperial Council of Agricultural Research, and a representative was sent to South Africa to obtain first-hand information with the view of considering the possibility of establishing an Angora goat industry in certain parts of India where similar goats already existed. Some assistance was also given to the improvement of village goats and poultry.

The main problem of animal husbandry in India is the improvement of the working bullock, and one of the most important measures taken to improve livestock was the organization in 1938 of the first All-India Cattle Show at New Delhi, at which representatives of the most important breeds of pure Indian Zebu cattle were exhibited for the first time in history. Such a central show is a logical development of the annual shows which are held in many Provinces and States, and at which local cattle are judged and prizes given, each year. These shows are a part of the measures taken by Provincial Governments to secure systematic improvement of livestock and have proved of the greatest value in suitable areas. If properly followed up, the central show should serve to advertise to the world that, for tropical countries, Indian Zebu cattle have no equals.

As it covers no less than about one third of the domesticated animals of the world, animal husbandry in India obviously requires much more extensive Government provision, apart altogether from the requirements of cash crops.

X-RAY ANALYSIS OF HÆMOGLOBIN

By M. F. PERUTZ

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It has been shown that very detailed X-ray diffraction photographs can be obtained from crystals of horse methæmoglobin suspended in concentrated solutions of ammonium sulphate. On rapid drying in air, these crystals contract by 42 per cent of their wet volume. The dried crystals give a poor diffraction pattern consisting of few low-order reflexions around the central spot[1].

A method has now been developed whereby it is hoped greatly to extend the information which X-ray photographs from single crystals of proteins have yielded up to the present. It is based upon a suggestion first put forward by Bernal, who observed that after the transition of chymotrypsin crystals from the wet to the air-dried state, the shrinkage is accompanied by alterations of the relative intensities of reflexions. Bernal concluded that if it were possible to obtain complete sets of reflexions in different states of hydration of the crystal, then this may enable us to distinguish between the effects of intra- and inter-molecular scattering and, eventually, to compute a direct Fourier synthesis of the molecular structure of the protein[1].

Single crystals of horse methæmoglobin can be made to contract so slowly that the complete drying process occupies several days. In addition, it was found possible to arrest the contraction over periods of weeks at stages of hydration intermediate between the wet and the air-dried, leaving sufficient time at each stage to record the reflexions from the principal crystal zones. So far the following results have been obtained:

(*a*) *Cell dimensions and optical properties.* Horse methæmoglobin crystals are monoclinic and belong to the space group $C2$, with two molecules in the unit cell. The cell dimensions at various degrees of contraction are given in the accompanying table. It is seen that b stays constant throughout the contraction, while a does not change until the final stage 4, when it suddenly shrinks from 109 A. to 104 A. The most important variable is the c spacing, which contracts by a total of 29 per cent. The angles between the optical extinction directions and the a axis remain unchanged during the transition from stage 1 to stage 2. At stages 3 and 4 the crystals had become too opaque for optical examination.

CELL DIMENSIONS AT DIFFERENT STAGES OF SHRINKAGE

Stage of shrinkage	a	b	c	β	$c \sin \beta$	Volume (A.^{3})	Contraction per cent
1 Wet	109 ± 0·5	63·8	55·1	111·1	51·4	357,000	—
2 Intermediate	,,	,,	51·4	116·2	46·1	321,000	10·3
3 ,,	,,	,,	53·5 ± 0·3	127·5 ±0·5°	42·3	294,000	17·7
4 Air-dried	104 ± 1·5	,,	54·1 ± 1·0	137·5 ±1°	36·5 ± 0·5	242,000	32

Probable errors are given wherever they exceed 0·2 A. or 0·2°.

(*b*) *Changes of diffraction pattern.* Shrinkage of the crystals has the effect of increasing the intensity of the diffuse background relative to that of the Bragg reflexions; it also causes the latter to fall

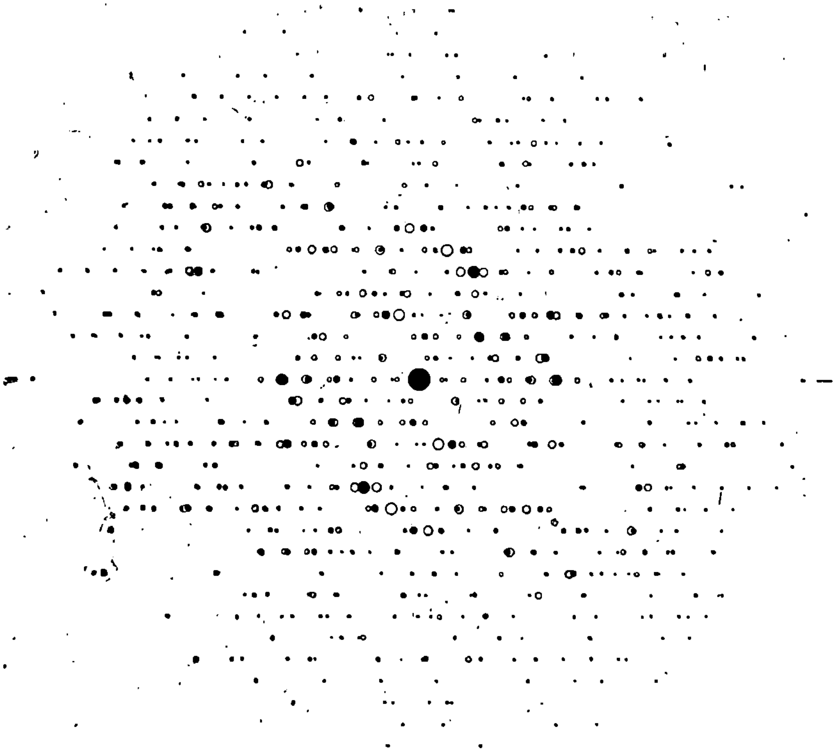

Fig. 1.

Distribution of F'^2 in the reciprocal lattice plane $h0l$.

The large circle in the centre is the origin. The c^* axis is horizontal.

off more rapidly at larger angles θ. While the patterns at the two intermediary stages show almost as much detail as those obtained from wet crystals, all reflexions of spacings smaller than 7 A. vanish in the case of the air-dried crystals.

The greatest changes in the relative intensities are to be expected in the $h0l$ reflexions, since all contraction takes place in the b plane. Fig. 1 consists of the superimposed pictures of the reciprocal lattice planes $h0l$ for the stages 1 and 3 respectively. The blank circles are drawn at the reciprocal lattice points belonging to stage 1, the blacked circles at the appropriate points for stage 3. The areas of the circles are proportional to F'^2_{h0l}. A temperature factor of $e^{-60\sin^2\theta/\lambda^2}$ was applied to the F'^2 values for stage 1, so as to adapt their rate of falling off to that observed at stage 3. It will be noted that there exist definite regions in reciprocal space where F' tends to have high values and others where it tends to vanish, and that these regions tend to occupy identical positions with respect to the origin and the c^* axis, irrespective of the degree of shrinkage.

(*c*) *Patterson-Fourier projections* on the b plane have been prepared for the stages 1, 2, 3 and 4. Those for stages 1 and 3 are illustrated in Fig. 2. If these two maps are superimposed so that the centres and the a axes coincide, then the positions of the majority of peaks also coincide. Moreover, the peaks show striking similarities in shape. If several unit cells are drawn of each of the two projections and the two large maps so obtained are superimposed with their a axes and one row of origins coinciding, then the effect shown in Fig. 3 is seen. The map can be divided into regions which are parallel to the a axis. Proceeding from the line of superposition (A in Fig. 3) there is first a region where both the maxima and the outlines of all major peaks coincide (region AP or AQ). Next comes a region where the correspondence between the outlines gradually vanishes and where the peaks which belong

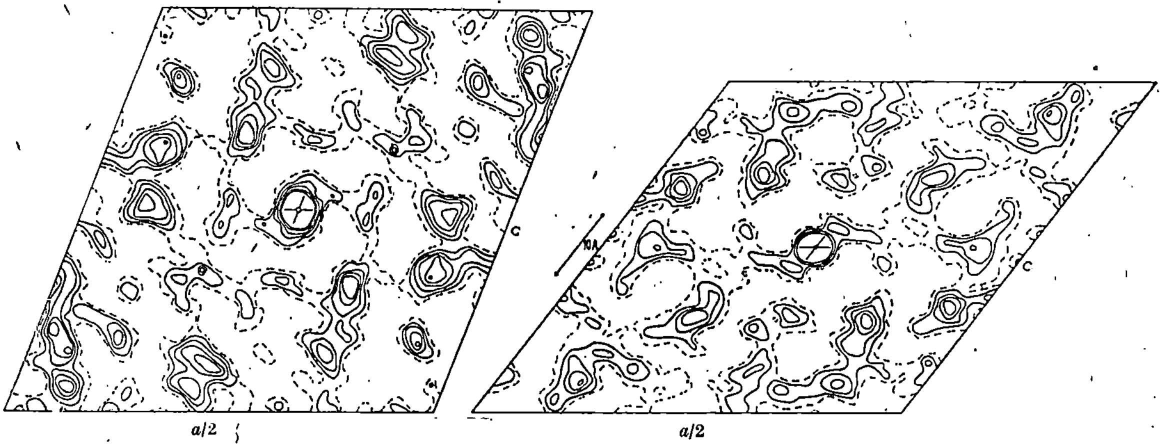

Fig. 2.

(*a*) Patterson (x,z) prepared from $F'^2_{h0l} \cdot e^{-60\sin^2\theta/\lambda^2}$ of stage 1, wet crystal; (*b*) Patterson (x,z) prepared from F'^2_{h0l} of stage 3, partially dried crystal.

In both diagrams the contours are drawn at intervals of 50 and the negative contours are omitted. The dashed line is the zero contour. The higher contours near the origin are omitted and the origins are marked by axial crosses.

to the contracted crystal tend to be displaced towards the line *A* (shaded region *PR* or *QS*). Finally, beyond this second region, no relation exists between either the outlines or the positions of the peaks (beyond *R* or *S*). The first of the three regions extends to a spacing of ~15 A. from the line of superposition, the second from 15 to ~21 A. It should be noted that no reflexions with spacings smaller than 3 A. have been used for the Fourier summations and that in consequence the maps cannot reveal any detail smaller than 1·8 A.[2]

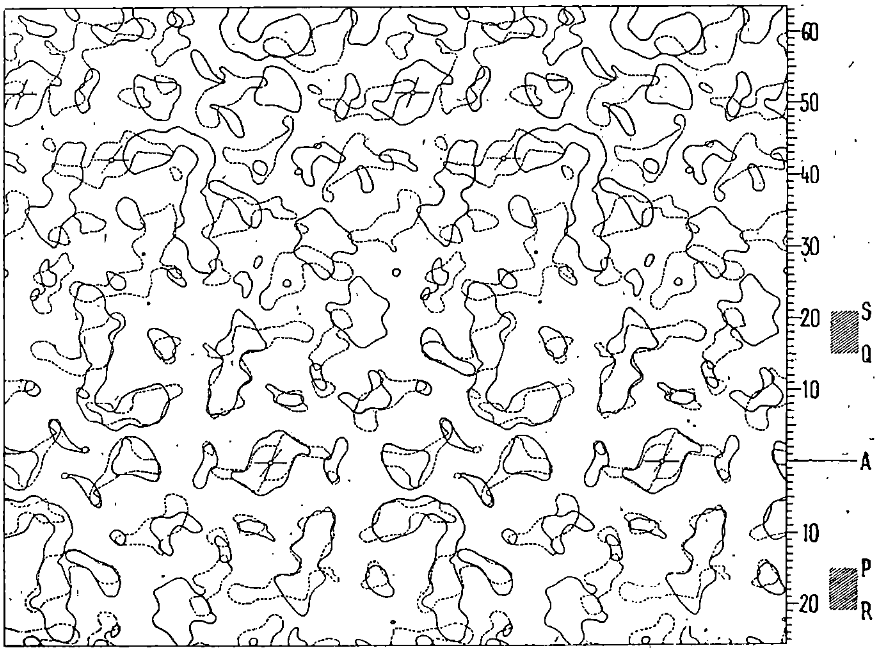

Fig. 3.

Superposition of several unit cells of each of the diagrams shown in Fig. 2.

All contours with the exception of the + 50 contour are omitted. The full contours and crosses correspond to the wet crystal (Fig. 2a), the dashed ones to the partially dried crystal (Fig. 2b). *A* marks the line of superposition and is parallel to the *a* axis. The scale is in A.U. The diagram shows only the outlines of the major peaks and not their maxima.

The results lead to the following conclusions concerning the molecular structure of hæmoglobin:

(I) The rigidity of the crystal along the *b* axis shows that the molecules must be linked together in this direction. Each of the two molecules in the cell lies on an axis of twofold symmetry parallel to *b*. Hence the diameter of the hæmoglobin molecule in this direction must be equal to the length of the *b* axis, that is, 64 A.

(II) Optical and X-ray data go to show that throughout the shrinkage the hæmoglobin molecules maintain their orientation relative to the *a* and *b* axes, despite the very great changes in the angle β. This orientation can be maintained only if the molecules form coherent sheets extending through the crystal parallel to the *c* plane, with layers of water and probably ammonium sulphate between the protein sheets. On drying, the layers move together and simultaneously slip over one another, thereby increasing the monoclinic angle (Fig. 4). Additional evidence for the existence of a sheet structure is the tendency of the crystals to break up into fragments parallel to the *c* plane under various conditions leading to dissolution or denaturation.

(III) Certain conclusions could be drawn concerning the thickness of the protein sheets, that is to say, the distance apart of two neighbouring water layers, if it could be decided which of the peaks in Fig. 3 are definitely of intramolecular origin. It can be shown that if two corresponding peaks at different shrinkage stages coincide and are closely similar in shape, then it is highly probable that they belong to the intramolecular type. On the other hand, if two peaks do not coincide, it does not necessarily follow that they are not of the same type. Thus we can be reasonably certain that the peaks in the region *AP* (0–15 A.) are all intramolecular, but no decision is possible as regards most of the peaks beyond 15 A. In consequence, it is certain that the distance apart of two neighbouring water layers is greater than 15 A. On the other hand, it cannot be greater than 36·5 A., as this is the *c* spacing in the air-dried crystals. Furthermore, each molecule lies on an axis of twofold symmetry. These conditions limit the number of possible arrangements to two. Either the hæmoglobin molecule must consist of two sheets of protein of 18 A. thickness each with one layer of water and possibly salt in between, the two sheets being related by a twofold axis, or it consists of a single rigid sheet of 36 A. thickness, the sheet itself possessing twofold symmetry. No decision between these two possibilities can be made at the moment.

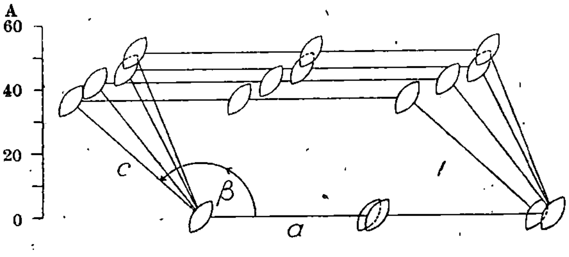

Fig. 4.

Changes in cell dimensions during successive stages of contraction.

The positions of the diad axes are marked; each of these is associated with one hæmoglobin molecule. The protein sheets mentioned in the text lie parallel to the *a* axis and normal to the plane of the paper.

(IV) The dried hæmoglobin molecule is seen to be a platelet 36 A. thick; it is 64 A. long in the direction of *b* and probably somewhat shorter along *a*. Elongated ellipsoids of axial ratios 1 : 4 or 1 : 5, such as those proposed by Polson[3] and Neurath[4], are incompatible with the crystal structure.

Full details will be published elsewhere.

I wish to thank Sir Lawrence Bragg for all he contributed to this research in many discussions on the problem and for his constant help and encouragement; also Prof. D. Keilin, who helped me to overcome many of the difficulties I encountered while growing the crystals, and gave me much stimulating advice. I am grateful to the Rockefeller Foundation for the grant which makes this research possible.

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[1] Bernal, J. D., Fankuchen, I., and Perutz, M. F., NATURE, **141**, 523 (1938).

[2] Bragg, W. L., and West, J., *Phil. Mag.*, **10**, 823 (1930).

[3] Polson, A., *Koll. Z.*, **88**, 51 (1939).

[4] Neurath, H., *J. Amer. Chem. Soc.*, **61**, 1841 (1939).

OBITUARIES

Prof. Jean B. Perrin, For. Mem. R.S.

It was with great regret that I saw the announcement of the death in New York on April 17 of Prof. Jean Perrin. He had many friends in England who will feel that we have lost a staunch ally, for it will be remembered that during the War of 1914–18 he was of the greatest assistance to every one engaged in scientific work for the Government departments. He was himself scientific adviser to the French Government, and was keenly interested not only in what was being done in Paris but also in the work done in England, especially the development of tanks. He disliked the Germans very much, and during the whole of the period 1914–18 and shortly before this War broke out the spirit that animated him was "Il faut écraser les Boches". It was some consolation to know that he and his son had got out of Occupied France and gone to the United States.

Early in his scientific career, more than forty years ago, Perrin was elected professor of physical chemistry at the Sorbonne, and since then he has made many original investigations in atomic physics, for which he will always be remembered, as they are included in all modern treatises on these subjects.

Perrin's earliest experiments were designed to determine the nature of cathode rays and the conductivity of gases produced by the action of Röntgen rays and radioactive substances. At that time Varley and Crookes maintained that the cathode rays were material particles charged with negative electricity, which were repelled from the cathode and acquired large velocities under the action of the electric force. But the early experiments which were made to detect the charge were inconclusive, and other physicists maintained that the rays were a form of undulatory motion of the ether. The problem of determining the nature of the rays was settled by Perrin, by experiments with apparatus which showed conclusively that the rays were charged negatively.

But the work for which Perrin is best known is his experimental investigation of the Brownian motion. This investigation was designed with the object of determining the energy of agitation of molecules, from which it is possible to deduce the number of molecules in a cubic centimetre of a gas. There were several indirect methods of estimating that number but the results varied within wide limits. Perrin in his method of determining the number relied on a general theory of motion of particles, which implied that the mean energy of agitation of small particles suspended in a liquid was the same as that of a molecule of a gas. He succeeded by very remarkable original methods in determining the energy of agitation of the particles and thus deduced the number of molecules in a cubic centimetre of a gas.

Perrin's work "Les Atomes" is one of the most popular scientific publications. It deals with the discoveries made in molecular physics during the very active period after the discovery of Röntgen rays and radioactive substances. Before the 1936 edition came out, 30,000 copies had been sold. He also wrote a very interesting book in 1935 entitled "Grains de matière et de lumière", where he gave a most vivid account of modern theories of radiation, and discussed several problems which agitate the minds of physicists.

Perrin never seemed to change; he was just as lively and original in his conversation a few years ago as he was when he was first appointed to be professor at the Sorbonne. He took the greatest interest in young people engaged in research, and had a party for them once a week in his laboratory where discussions took place on all sorts of subjects. What was most pleasant about these meetings was the boyish interest Perrin took in experiments, for he always placed more confidence in experimental investigations than in mathematical theories.

When on one occasion another professor, after trying to persuade him to accept a theory he had propounded, said "At least you must admit there is something in it", Perrin replied: "My dear ——, it would be difficult to propound a theory that was entirely false."

He will be greatly missed by all French men of science, and also by his friends in England, for nothing added so much to the pleasure of a visit to Paris as a meeting with Perrin.

J. S. TOWNSEND.

Dr. T. B. Macaulay

THOMAS BASSETT MACAULAY, whose generous benefactions made possible the foundation of the Macaulay Institute for Soil Research at Aberdeen, died in Canada on April 3.

Mr. Macaulay who was born at Hamilton, Ontario, on June 6, 1860, was descended from the same family as Macaulay the historian, the Macaulays of Uig in the Island of Lewis. His grandfather migrated to Aberdeenshire and his father, Robertson Macaulay, was born at Fraserburgh in that county, but went to Canada as a young man and later became president of the Sun Life Assurance Company of Canada.

Dr. T. B. Macaulay entered the service of that Company in 1877, and held the posts of actuary, secretary, director and managing director, finally succeeding his father as president. He played a great part in expanding the Company from a very small concern to one of the most important corporations of its kind in the world. He was a fellow of the Institute of Actuaries of Great Britain and a charte member of the Actuarial Society of America of which he was twice president. A leading figure in his profession, he received the honorary degree of LL.D. from the Universities of McGill, Edinburgh and Aberdeen.

Dr. Macaulay's interests outside insurance wer widespread and ranged from the development o trade between Canada and the West Indies to medica research and agriculture. During the War of 1914–1 he was Canadian chairman of the National Committe on Food Resources. He had the experimenting instinct highly developed. On his own farms at Hudso Heights near Montreal he built up one of the fines Friesian herds in North America, and for many year carried out experiments on the development of strain of maize and soya beans with the view of obtainin early varieties of good quality suitable for Canadia conditions. The work was not delegated to othe but was carried out personally by this busy business man in his limited leisure. The success which he achieved in his experimental work showed that had he elected to become a professional scientist he would have been as eminent as he was in his chosen profession.

Dr. Macaulay contributed generously to numerous causes both in Canada and Great Britain. In memory of his forebears he gave many thousands of pounds for educational, hospital, welfare and other purposes in Lewis and in Fraserburgh, but his benefactions were national as well as local. He was interested in genetics and in research on the endocrine glands, and contributed large sums to the Animal Breeding Research Department of the University of Edinburgh. Probably he will be remembered best as the founder of the Soil Research Institute at Aberdeen which bears his name. The buildings and equipment, including a demonstration farm on peatland in Lewis, were provided by Dr. Macaulay on the understanding that the Government would meet the cost of maintenance. He possessed tireless energy and unbounded enthusiasm. One of his ambitions was to bring about an improvement of the poorer classes of land in Scotland and during his visits to the country much of his time was spent in furthering this object. His influence with the crofters in Lewis was very great and he succeeded in bringing about many improvements where others had failed. The results of peat reclamation experiments carried out in Lewis were later applied by the Macaulay Institute in the successful reclamation of peatland in Lanarkshire on behalf of the Commissioner for the Special Areas.

It was my privilege to become one of Dr. Macaulay's friends and to stay with him several times in Canada, where I saw something of his happy home circle and of his scientific pursuits. He was a man of great sincerity and strength of character, kindly and always anxious to help his fellows. He lived simply and gave generously.

It was a source of great satisfaction to him during his last visit to Great Britain four years ago to stay at the Institute which he was instrumental in found- ng and to see the realization of some of his cherished ambitions.

W. G. Ogg.

Mr. F. J. Selby, C.B.E.

Mr. Francis James Selby, C.B.E., one of the mall band of workers who formed the staff of the ational Physical Laboratory in its early days nd helped to develop it from small beginnings o an institution of world-wide renown, died on arch 5. He joined the staff in 1903 to take charge f the prediction of tides which the Laboratory was bout to carry out for the Indian Government, and o establish a Division for Optics to supplement the ork of the Observatory Department at Kew. elby was also secretary to the Director, an office hich, if the range of his activities were considered, ould have been better described as secretary of e Laboratory. In this position, which he made e of great importance in the Laboratory organiza- on, he took a large share of administrative respons- ility. His sympathy with the policy of Sir Richard azebrook particularly fitted him for this work, and ose who knew the Laboratory well realized that it s no less fortunate in its secretary than in its first rector. Everyone trusted him and valued his dgment and advice.

In 1909 Glazebrook was appointed chairman of the newly formed Advisory Committee for Aeronautics; Selby was chosen and continued as secretary until 1919, when the committee was replaced by the Aeronautical Research Committee. His services were recognized by the award of the C.B.E.

In 1918, shortly before the Government accepted financial responsibility for the Laboratory in place of the Royal Society, the office of Secretary of the Laboratory was formally established, with Selby as the first holder. In the following year Sir Joseph Petavel became director, and Selby continued to give most loyal service. He retired in 1932 on reaching the age of sixty-five.

Selby's special training was in mathematics, first at University College, London, where he greatly appreciated the teaching of Karl Pearson, and afterwards at Trinity College, Cambridge. He graduated as sixth wrangler in 1891 and later became mathematical master first at Bristol Grammar School and then at Repton. At the Laboratory, Selby retained a keen interest both in mathematics and in education. There was probably no important paper on relativity or the quantum theory that he did not read critically. He took an active interest in the further education of junior members of the Laboratory staff.

On his retirement, Selby intended to write a history of the early days of the National Physical Laboratory, a task for which he had unique qualifications. Unfortunately, little more than two years after his retirement, when the work was only partly done, he had a stroke and his memory was affected to an extent which made the completion of the history impossible.

Selby was twice married, and is survived by a daughter.

T. Smith.

Mr. C. Oldham

Charles Oldham was born at Lincoln on April 16, 1865, but at the age of six the family went to live at Sale in Cheshire. It was at the preparatory school there that began the life-long friendship with T. A. Coward that was later to bear fruit in the classical account of the "Birds of Cheshire".

Until his retirement in 1927, the claims of his professional duties as assistant manager of the Manchester office and later of the London office of the Commercial Union Insurance Company, permitted him little leisure to pursue his scientific studies. Despite this temporal handicap, he became an acknowledged authority on British malacology and ornithology. He it was who contributed the field notes for the first edition of Witherby's "Handbook of British Birds", and he made notable contributions to the study of British land and freshwater Mollusca and especially in the critical genus of the Pisidia, his specimens of which are now in the national collection. It is at once a tribute to his characteristic thoroughness and physical endurance that, in the course of the study of this group, he examined almost all the very large number of tarns in North Wales.

Oldham was a field naturalist of the best type, outstanding alike in the accuracy of his observations and the breadth of his knowledge, and by no means the least valuable of his services was his influence upon those with whom he came in contact. For ten years Oldham was one of the honorary secretaries of the Hertfordshire Natural History Society and its president in 1920. His annual reports on the birds of that county were models of discriminating observation. For twenty-three years he was treasurer of the Conchological Society and he served as vice-president of the Linnean Society, the Ray Society, the British Ornithological Union, the Malacological Society, the British Ecological Society, and on the committee of the British Ornithological Club.

Like all men who possess not mere ability but also wisdom, Oldham was essentially modest and his published papers, though numerous and valuable, are but a poor indication of the profundity and wealth of the knowledge that was so freely placed at the disposal of others. To accompany him in the field was to enjoy a liberal education and to share the riches of a well-plenished mind, whilst the privilege of his friendship was both an inspiration and a stimulus. His loss to science is the greater because in these days of "learning more and more about less and less", the number of those who combine the insight of the specialist with a balanced perspective is growing fewer although the need for them increases.

E. J. SALISBURY.

WE regret to announce the following deaths:

Lieut.-Commander L. C. Bernacchi, who wa physicist to the Southern Cross Antarctic Expedition, 1901–4, on April 24, aged sixty-five.

Prof. H. L. Bowman, Waynflete professor of mineralogy and crystallography in the University of Oxford, on April 22, aged seventy-seven.

Dr. Arthur Michael, emeritus professor of organic chemistry at Harvard University, on February 8, aged eighty-eight.

Prof. Carl Oppenheimer, editor of *Tabulæ Biologicæ*, *Enzymologia* and author of well-known books on biochemistry, aged sixty-seven, on December 24, at The Hague.

Colonel M. O. Tandy, O.B.E., formerly of the Survey of India, on April 18, aged sixty-eight.

Dr. W. E. Thrift, provost of Trinity College, Dublin, and formerly Erasmus Smith professor of natural and experimental philosophy in the College, on April 23, aged seventy-one.

NEWS and VIEWS

Planning and Rebuilding in Britain

IN his first official statement in the House of Lords as Minister of Works and Buildings, Lord Portal emphasized that the policy initiated by his predecessor, Lord Reith, still holds good. Lord Portal was replying to inquiries by the Bishop of Winchester, who voiced the wide anxiety as to whether the recent changes at the Ministry of Works and Buildings meant a change in the Government's intentions. He emphasized that unless planning took a prominent place in housing reconstruction, there would be chaos through the rivalry of competing authorities and uneconomic use would be made of the land, with the attendant spectacle of distressed areas.

Lord Portal explained that the broad objective of the new Ministry would be the right use of the land of Great Britain for all purposes. The Minister would have the responsibility of seeing that policies in regard to agriculture, transport, etc., were properly co-ordinated. Further legislation will be introduced in the light of reports to be submitted very shortly by Mr. Justice Uthwatt and Mr. Justice Scott. Considerable reduction in the number of planning authorities has already been made by voluntary arrangement. Lord Portal also said he is working in close collaboration with the Paymaster-General in considering the relation of planning to the need for the preservation of areas of natural beauty and especially the coastline. With regard to the building industry, it would be essential that, directly the War ends, the industry should be ready, through organization, to cope with the demands which would be made on it. The personnel of the industry would have to be dealt with on a new basis.

The Central and Supplementary Registers

THE Minister of Labour stated last winter that it was proposed to merge the Central and Supplementary Registers in a new Appointments Department of the Ministry of Labour and National Service. This has now been done. The Central Register covers those with scientific and technical qualifications, while the Supplementary Register includes those with administrative and managerial qualifications and others, not on the Central Register, with scientific and professional qualifications. It is stated that there is now a lack of men in nearly every branch covered by the Central Register. As regards the Supplementary Register, every effort will be made by the new Appointments Department to make the best use of the varied qualifications which are represented. The Register will be revised at intervals of two months, and it is intended to arrange personal interviews with all those whose names are on it. It will be decentralized to some thirty appointments offices outside London, all of which will be linked with the Appointments Department in London at Sardinia Street, Kingsway, W.C.2. The Centra Register is being moved to the same address. These Registers, if properly handled, should prove of immense value in assessing the professional resources of the country for both present and future needs.

Association for Planning and Regional Reconstruction

THE Association for Planning and Regional Reconstruction, Ltd., is incorporated as a limited company not for purpose of profit, and its board is responsible for the direction and co-ordination of research into post-war problems. While the polic of the Association is to co-operate with individuals organizations and local and national authorities, it does not itself undertake direct works of reconstruction. Its object is to serve as a centre for research for which purpose it employs a small trained research staff, and to advise and to suggest, as well as t correlate experience. It also endeavours to train nucleus of men and women in the technique o planning in its broadest sense. The work of th School of Planning and Research for Nation Development is now carried on through the Association.

The Association has issued a series of four-pa broadsheets setting out simply and concisely th results of each piece of research. Of the broadshee so far issued, one contains general information regarding the work of the Association and others deal with the distribution of fresh food, human wastes, their collection and disposal, and a summary of existing methods of disposal. The first of these outlines a system of fresh-food production and distribution, assuming a network of 'control farms' and 'fresh food centres'. Those on human wastes summarize suggestions as to how such wastes can be used to maintain soil fertility, and give a technical analysis of present systems of disposal. The Association is also engaged on the preparation of a series of maps, designed to present existing statistical and other information on various problems in visual form. It is also studying the problems of a service to promote positive health and the lay-out of a 'health centre', standards governing housing density, prefabrication possibilities in housing construction, and the marketing of goods in relation to planning.

Scientific Data in Glass Technology

In his presidential address to the Society of Glass Technology, delivered on April 14, Dr. S. English discussed "The Commercial Use of Scientific Data". After a brief review of the rapid development of the science of glass technology during the past twenty-five years, and the importance of the results obtained in their application to manufacturing processes, the problems of illuminating glassware of the diffusing type were considered in detail. Three essential requirements of such glassware are that it should be (1) practicable from the manufacturing point of view, (2) technically correct from the illuminating point of view, (3) artistically correct. The problem of glare was emphasized in relation to the adaptability of the human eye to an enormous range of illumination intensities from 2,000 to 4,000 ft.-candles on a bright summer day to 0·002-ft. candles for A.R.P. lighting. Diffusing glass envelopes reduce the glare and increase the detail comprehended by the eye by removing the intensely bright source from direct vision.

The properties of completely diffusing opal glasses in conjunction with metal filament lamps were then described. In general, the percentage transmission of opal glasses is always higher for directed light than for diffused light (2·5 per cent increase). The proportion absorbed is always less for directed than for diffused light, by approximately 1–5 per cent, and the proportion reflected is usually less for directed than for diffused light. Examples were given of the use of physical data for the predetermination of the performance of a lighting fitting made in flat opal glass plate, illuminated on one side by a single electric filament lamp, with and without a second plate behind the lamp to serve as reflector, and of a complete opal sphere enclosing the lamp. The efficiency of an opal sphere as a lighting unit depends on the glass, which must be a perfect sphere of uniform thickness, with no neck opening, and giving perfect diffusion of transmitted and reflected light; and on the lamp, which must give a uniform light distribution. The view was expressed that the British illuminating glassware industry should endeavour to provide the whole of the post-war requirements of Great Britain in this field.

Jig Borer Microscope

The recent introduction of the "Watts" jig borer microscope provides a valuable optical accessory for se with high-precision machine tools such as jig borers, and tool-room milling machines. Its purpose is to enable the axis of the machine to be accurately located in relation to a datum mark on the work-piece. In construction, it consists of a high-power microscope the optical path of which is bent so that the user can conveniently inspect the work from one side when the instrument is set up in the spindle of the machine. The microscope is mounted on a taper shank—No. 4 morse taper is used in the standard model but any of the usual tapers can be supplied—and the shank is inserted in the spindle. In this position the objective axis of the microscope coincides with that of the boring spindle, which the operator is thus enabled to bring within an accuracy of 0·00005 in. to the desired position.

The optical system is so arranged that the intersecting points of the graticule lines when viewed through the eye-piece, which is of the screw-focusing type, are superimposed on the point where the projected axis of the spindle falls on the work-piece. The microscope, which has a power of $\times 45$, can therefore be used (*a*) for setting the spindle over a small punch mark, (*b*) for setting the spindle over a line marked on the work-piece, or (*c*) with the aid of a reference square, for setting the spindle in the plane of any desired surface of the work-piece. The graticule or cross-lines seen in the eye-piece of the microscope are centred relative to the taper shank, but in order to compensate for a small degree of spindle run-out, should this be experienced, provision is made for the adjustment of the diaphragm to enable the cross-lines to be re-set. As the spindle is free to rotate, the instrument has the merit of being self-checking by turning it through an angle of 180°, and a rotatable reflector is arranged so that the light from any convenient lamp can be brought to bear on the job. The instrument is thus well designed to simplify what is a fundamentally difficult setting in precision machine work. The makers are Messrs. E. R. Watts and Son, Ltd., 123 Camberwell Road, London, S.E.5, from whom further details can be obtained.

Phenology of 1941

Repeating its admirable promptness of last year, the Royal Meteorological Society has issued its fifty-first annual phenological report, for the year 1941, under the editorship of Major H. C. Gunther, although it is somewhat abridged from its pre-war size. It is interesting because of the late spring and the amends of a belated summer, with a remarkably green autumn countryside and an unusually late defoliation of trees, although autumn colours were not much in evidence. The migrant birds arrived punctually in the south but late in the north; there were average numbers of the immigrant painted lady and red admiral butterflies and of the silver Y moth, while clouded yellow butterflies were reported from many parts of the country, including the north. Observations on the magpie moth and the meadow brown butterfly in relation to the rise in temperature for the June-July warm spell which followed the cold late spring illustrated how quickly certain insects may respond to the influence of a favourable spell following adverse conditions. Observations on the dog-rose furnished clear-cut evidence of the preponderating importance of the weather of the moment as compared with any latent tendencies due to a previous season, for in 1941 the flowering dates for the south-east were not less than 16 days later than those for 1940, when the south-east dates were slightly earlier than the dates for the north-west. But in 1941 the north-west dates of this flower were slightly earlier than the south-east dates. Despite the War, reports were sent in from 277 phenological observers in the scheme—only twelve less than the previous year.

Tuberculosis in Ecuador

In a recent article (*Bol. Of. San. Panamericana*, 21, 128; 1942), Dr. Jorge Higgins, director of the Anti-tuberculous Dispensary of Guayaquil, Ecuador, states that of Ecuador's three geographical regions, the coast, which has an average temperature of 81° F., is the most severely affected by tuberculosis. The port of Guayaquil, which has a population of 200,000, has the highest tuberculosis mortality in the world. The anti-tuberculosis campaign began in 1934, when the first dispensary in Guayaquil was established. A similar dispensary was afterwards opened in Quito, and more are being planned for the rest of Ecuador. During 1939, the Guayaquil dispensary provided 2,609 medical consultations, 2,406 fluoroscopic examinations, 683 pleural insufflations and 1,431 laboratory examinations; 1,169 patients were admitted and 1,831 home visits were made. A large sanatorium has been started in Guayaquil supported by a new organization called the Liga Antituberculosa Ecuadoria. Poverty, which is one of the most important factors in the causation of tuberculosis, is being partially offset by the introduction in several cities of popular restaurants where good food is supplied at popular prices. Milk stations are also furnishing milk free to the infants of poor families. Several hundred dwellings have been destroyed and their place taken by many hygienic houses for workers.

Historical Medicine and Science

Schuman's, of 30 East 70th Street, New York, have sent us their latest catalogue entitled "Medical Miscellany, List 'D'," containing an annotated list of rare books and first editions of works on historical medicine and science. In a special section on war medicine are listed the "Opera omnia medica et chirurgica" of Botallo (1660), James Handley's "Colloquia Chirurgica" (1705), Thomas Trotter's "Observations on the Scurvy" (1792), George Guthrie's treatise on "Gun-shot wounds" (1815), and William Braisted's "Report on the Japanese and Russian Medical Organization in the Russo-Japanese War" (1906) among many others. Mention may also be made of Pico della Mirandola's "Opera Omnia" (1506), the third Latin translation of Rhazes' works (1510), Thomas Willis's "De anima brutorum" (1672), Astruc's "De morbis venereis" (1740), David Brewster's "Treatise on the Kaleidoscope" (1819), Johannes Mueller's "Handbuch der Physiologie des Menschen" (1835–40), Cockayne's "Leechdoms, Wortconning and Starcraft of Early England" (1864–66), Allbutt's work on "The Use of the Ophthalmoscope" (1817), and Haeser's "Lehrbuch der Geschichte der Medicin" (1875–82).

Admiral Dumont d'Urville (1790-1842)

By a terrible railway accident at Versailles on May 8, 1842, France lost one of her most eminent scientific explorers, Admiral Jules-Sébastien-César Dumont d'Urville, whose voyages not only added much to geographical knowledge but also enriched immensely the natural history collections of the Paris museums. Born in Normandy on May 23, 1790, d'Urville entered the Navy at the age of eighteen, and two years later in the *Chevrette* visited the Black Sea. In the Isle of Milo his attention was turned to the famous statue of Venus, which was afterwards bought by the French Ambassador to Constantinople and now stands in the Louvre. In 1822 d'Urville was appointed to the *Coquille*, commanded by Duperrey, and in the course of a voyage in Oceania he made a collection of three thousand plants and another of twelve hundred insects. Returning home in 1825, he was appointed to the command of the ship, which was then renamed the *Astrolabe*. Leaving Toulon on April 25, 1826, the ship visited Australia, New Zealand, New Caledonia, New Guinea, the Carolines and other islands in the Pacific. The ship finally reached France again on March 25, 1829. D'Urville's last voyage, made during 1837-40 in the *Astrolabe*, accompanied this time by the *Zélée*, took him to the Antarctic. It was while he was engaged in writing the account o this voyage that he met his death. The train he was in caught fire, and the carriage doors being locked some fifty-two persons, including d'Urville's wife and son, were burnt to death.

Photography in Science, Medicine and Industry

The Association of Scientific Workers is organizin an exhibition which, it is hoped, will be held i November at the premises of the Royal Photographi Society. The exhibition is to illustrate the applications of photography to science, medicine and industry with the view of making such information mor generally available and better known to the public The Photographic Committee of the Association anxious to obtain examples of such work from a wide a variety of sources as possible, appeals to thos who may be able to provide exhibits to write to th Honorary Secretary, Photographic Exhibition Committee, Association of Scientific Workers, 73 Hig Holborn, London, W.C.1, for further details.

Announcements

Dr. Helen Bancroft (Mrs. Simmons), known fo her work, especially at the Imperial Forestry Institute, on the anatomy of recent and fossil plants floral anatomy and systematic botany, is interne with her husband, at Vittel. She would be ver glad to receive letters from her scientific friend during her isolation from scientific life. Her addres is: Mrs. Helen Holme Simmons, Frontstalag 19 No. 111 Grand Hôtel, Vittel (Vosges), France.

The Association of Scientific Workers has forme a committee to help in solving the special problem with which foreign men of science in Great Britai are confronted in assisting in the war effort. Foreig scientific workers interested in the work of th committee should write to the Secretary, Foreig Scientists Committee, Association of Scientif Workers, Hanover House, 73 High Holborn, W.C.

Erratum: In the communication from Dr. J. Monteverde which appeared in Nature of April 2 p. 472, the antigenic formula of *Salmonella bonariensi* through an oversight, lacks the symbol for phase of the flagellar antigen. The complete formula $VI_1 . VIII$; $i \longleftrightarrow e, n$. . . . (phase 2 is still und examination).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Effect of Shredding and Grating on the Vitamin C Content of Raw Vegetables

It is now known that a rapid loss of vitamin C takes place when the cells of vegetables are mechanically broken. During the analysis of vegetables for vitamin C, for example, it is important that all grinding or other subdivision of tissues should be carried out in the presence of metaphosphoric acid so that vitamin C-oxidase shall be inhibited before it has any opportunity of coming into action.

The loss of vitamin C which occurs in cooking has led to widespread recommendations that shredded or grated raw vegetables be eaten in the form of salads. Since the preparation thus of raw vegetables must lead to the disruption of a proportion of the plant cells, it was thought of interest to carry out the following experiments to investigate the extent of any destruction of vitamin C.

1. *Savoy Cabbage.*

Savoy cabbage from which the coarse outer leaves had been removed was cut into quarters and the four parts treated in one of the following ways:

(*a*) Grated with a household grater as commonly used for cheese or bread crumbs. The leaf was considerably bruised and some discoloration occurred.

(*b*) Shredded with a household shredder as used for suet. Some bruising was observed but not as much as in (*a*).

(*c*) Shredded with a sharp knife. No bruising or discoloration occurred.

Vitamin C determinations were carried out by the usual method of titration with 2.6 dichlorophenol indophenol on the lots of cabbage after 5, 10, 20, 30 minutes and 1, 2 and 3 hours standing in the laboratory. Replicates of the uncut quarter were analysed to determine the original vitamin C value.

STABILITY OF VITAMIN C IN GRATED AND SHREDDED RAW SAVOY CABBAGE.
(*Vitamin C mgm. per 100 gm.*)

Time	*a*	*b*	*c*
0 min.	50	50	50
5 ,,	34	48	48
10 ,,	34	44	48
20 ,,	31	44	50
30 ,,	34	46	48
1 hour	34	44	50
2 ,,	34	46	52
3 ,,	31	44	48

The results shown in the table above are in harmony with theoretical considerations. In *a*, an appreciable proportion of cells was destroyed and rapid loss of 4 per cent of the vitamin C occurred within five minutes. After this period there was no further loss. Less severe treatment *b* caused a similar loss of 0 per cent of the vitamin C. Process *c*, shredding with a knife, produced no significant destruction of vitamin.

Swedes

The previous experiment on savoy cabbage was repeated with swede. The same methods of shredding nd grating were used.

Although similar in principle to the results for abbage, the figures for swedes showed two differences. When grated, swedes lost a higher proportion of vitamin C than cabbage. The loss after three hours was 75 per cent compared with 34 per cent. After coarse shredding the losses were 39 per cent compared with 10 per cent. The more striking difference between cabbage and swede, however, was that while loss of vitamin C in the former was almost instantaneous, in the latter slow, continuous destruction occurred. With swede, as with cabbage, however, shredding or dicing with a sharp knife did not damage sufficient cells materially to affect the vitamin C content of the foodstuff.

STABILITY OF VITAMIN C IN GRATED AND SHREDDED RAW SWEDE.
(*Vitamin C mgm. per 100 gm.*)

Time	*a*	*b*	*c*
0 min.	36	36	36
5 ,,	31	38	—
10 ,,	28	32	32
20 ,,	25	28	34
30 ,,	22	29	31
1 hour	20	27	32
2 ,,	11	29	32
3 ,,	9	22	34

MAGNUS PYKE.

April 16.

Natural Breeding Sites of *Drosophila obscura*

MOST of the studies on the genetic structure of wild populations of Drosophila have been on animals trapped by means of a yeasted banana-agar or similar fruit traps[1,2,3]. The flies may thus have been drawn from a large number of small discrete breeding units, and hence general inferences are difficult. I have found a very marked deficiency in the number of males trapped in *D. subobscura* Collin and to a lesser extent in *D. obscura*, although the sex-ratio in cultures approximates unity, thus demonstrating the inadequacy of collections by means of baited traps.

For many years I had attempted to secure natural populations breeding *in situ* but with no success until the summer of 1939. In that year Mr. Klaus Rothfels, at my suggestion, examined trees for exudates and found large colonies of Drosophila feeding on the yeast growths of elm tree exudates. The two most common species were *D. subobscura* Collin and *D. obscura*. This discovery was remarkable for the additional fact that a high percentage of the *D. obscura* on the site were mutants of several forms, in very marked contrast both to the proportion of mutants of the same species trapped at some distance and to the proportion of mutants in *D. subobscura* on the site. We concluded that the site was a natural breeding site for *D. obscura* but that the other species merely fed there.

Mr. Rothfels and I were to have continued the work in the summer of 1940 but this was impossible due to his sudden departure. In the late summer of 1941 Mr. Forbes W. Robertson took the matter up again. He examined a large number of trees, beech, sycamore and elm with a few oak and ash, and found yeast patches only on six elms. These were all unhealthy trees from among a group of about two hundred elms within a radius of half a mile in a moist river valley. Three of the trees were definitely moribund. The Drosophila species feeding on the yeasts were *D. obscura*, a few *D. subobscura* and occasional *D. funebris*.

The exudate and bark from one tree were removed to the laboratory for examination. Among a varied fauna we found a number of Drosophila eggs and larvæ on the inner side of the bark. These were grown in the normal Drosophila culture medium, and from 150 larvæ picked off and a large number of other eggs and larvæ, 20 male and 29 female *D. obscura* emerged to the exclusion of all other Drosophila species. Hence we concluded that the patches on elm trees form a natural breeding site for *D. obscura*.

At present the culture conditions for this species present some difficulty, but these can almost certainly be overcome. When this is accomplished we shall be in a position to undertake the examination of the genetic structure of discrete populations in relation to their known ecology.

I am indebted to Dr. O. W. Richards for the information that he had once observed what appeared to be *obscura*-like forms feeding on an exudate.

CECIL GORDON.

Natural History Department,
Marischal College,
Aberdeen.
April 17.

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[1] Dobzhansky, Th., *Proc. 7th Int. Cong. Gen.* (1939).

[2] Dubinin, N. P., and co-workers, *Biol. Zh.*, 6 (1936).

[3] Gordon, Spurway and Street, *J. Genet.*, 38 (1939).

Resistance of a Soil Nematode to Changes in Osmotic Pressure

THE results detailed below are considered to be of sufficient interest to merit early publication. An amplified account will be published in the future, when a description will be given of the species of Rhabditis which was employed. The worms were cultured in an agar broth the osmotic pressure of which was equivalent to that of about 30 m*M*. sodium chloride.

On immersing the worms in distilled water, the body swells, but the alimentary canal swells more slowly than the rest of the body. Similarly, in concentrated saline solutions, the body shrinks, the alimentary canal shrinking more slowly than the remainder. These results show that water can pass into and out of the body down a gradient of osmotic concentration, and also that the main aqueous exchanges do not occur through the gut. Further work indicated that these exchanges occur through the general body surface.

During shrinkage in concentrated solutions, vacuoles are occasionally observed between the cuticle and hypodermis. By analogy with conditions in a plasmolysed plant cell, it seems likely that the cuticle is more permeable to the substances in solution than is the hypodermis. Further experiments with cyanide solutions also suggested that the living tissues of the body wall, rather than the cuticle, are primarily responsible for controlling the permeability of the body wall.

After about fifteen minutes in distilled water, the amount of swelling of the body of the worm is reduced. This reduction is not observed with injured animals, nor when *M*/100 potassium cyanide is used instead of distilled water. These results show that there is, in distilled water, an active method of osmotic regulation whereby the size of the body is reduced. The alimentary canal probably plays some part in this regulation, since fluid is ejected from the anus during the later stages of reduction in size.

On prolonged immersion in concentrated saline solutions, the body slowly re-expands. If, towards the end of this process, the worms are transferred to distilled water, the amount of swelling which is produced is less than that obtained with animals which had not re-expanded. This suggests tha in these conditions, osmotically active materi is passing out of the body. The avenue of escap could not be decided upon with certainty.

The conclusions reached contradict the genera impression that free-living nematodes can withstan osmotic changes because they possess an impermeabl cuticle[1], and indicate rather that this resistance i due to an active method of osmotic regulation. Th conclusion that the cuticle is relatively unimportan as an insulating covering, agrees with the conclusion reached as a result of past work upon parasiti nematodes[2].

WILLIAM STEPHENSON.

Dept. of Zoology,
King's College,
University of Durham,
Newcastle-on-Tyne, 2.
April 16.

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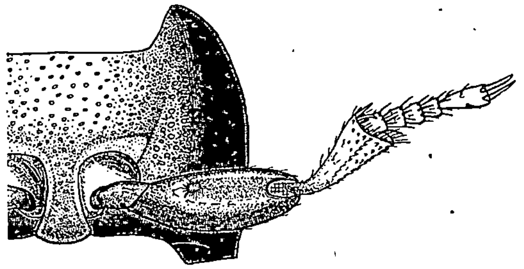
[1] Krogh, A., "Osmotic Regulation in Aquatic Animals", 44 (1939).

[2] Panikkar, N. K., and Sproston, N. G., *Parasitology*, 33, 214 (1941).

Secondary Sexual Characters of Triboliu

THE confused flour beetle, *Tribolium confusum* J du V., and the rust-red flour beetle, *T. castaneu* Herbst, are the most abundant and destructiv beetles infesting flour and other prepared cere products. *T. confusum* is also one of the insect most commonly bred in the laboratory for exper mental purposes. Hitherto it has been maintained[1,2], that there are no secondary sexual characters in th adult stage, and in consequence the beetles coul only be sexed in the pupal stage, a procedure whic is frequently very inconvenient.

I have recently found that the males of bot species have on the basal fourth of the ventral sid of each femur a shallow, oval pit from which aris numerous, erect, golden-yellow hairs. The female have neither the pit nor the associated brush hairs. In *T. castaneum* (see accompanying illustratio this pit is about 0·04 mm. broad, and the hairs a nearly as long as the breadth of the pit. In livin specimens of this species the presence or absence the pit and hairs can be detected with certainty wit a hand lens of × 15. Specimens to be sexed shoul be held with the back against the index finger an the thumb nail, which needs to be moderately lon pressed gently just behind the front legs. With little practice they can be sexed without injur Alternatively, the insect can be picked up by touchi its back with a wet brush, or, as suggested to me Dr. J. P. Harding, it can be held in a Rousselet liv box.



Tribolium castanum HERBST, MALE. VENTRAL VIEW OF LEFT FRONT LEG.

T. confusum has a similar but smaller pit (0·03 m broad) and is difficult to sex without the aid of binocular dissecting microscope under which the specimen may be held as described above. In the males of *T. confusum* the middle and hind femora also have pits though these are much smaller and more difficult to see than those of the front femora and usually contain only 2–4 hairs.

H. E. Hinton.

Department of Entomology,
British Museum (Natural History),
London, S.W.7.
April 9.

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[1] Brindley, *Ann. Ent. Soc. Amer.*, **23**, 751 (1930).

[2] Good, Tech. Bull. U.S. Dept. Agric., No. 498, 3 and 36 (1936).

[3] Park, Gregg, and Lutherman, *Physiol. Zool.*, **14**, 397 (1941).

Mitosis in Amœbæ

The life-histories of four large, free-living amœbæ have been worked out here; one, namely, *Amoeba lescheri* n.sp. not yet published. But except for *Amœba dubia* (Schaeffer) in which Sr. Bernardine (Dr. L. A. Carter) discovered it in 1913, mitosis had until recently not been demonstrated. In fact we doubted its occurrence.

Pending the publication of a full account of mitosis in these amœbæ and of the whole life-cycle of *A. lescheri* (n.sp.), we should like to state here that we have now also discovered the phenomenon of typical mitosis in the binary fission of (1) *Amœba proteus* γ (= *A. proteus* (Schaeffer); (2) *Amœba discoides*; and (3) *Amœba lescheri*.

Monica Taylor.
Carmela Hayes.

Notre Dame Training College Laboratory,
Dowanhill, Glasgow, W.2.
April 20.

Flow of Liquids in the Critical Region

In experiments on the flow of water in a long copper tubing, it was found that the inlet pressure must be maintained free from disturbances to the highest degree possible if flow in the critical région is to be analysed. When extraneous disturbances were eliminated, the flow in the tube falling between Reynolds' numbers 1,000 and 5,000 was found to fall into three distinct classes, all of which were different from both the viscous and the turbulent regimes. Strictly speaking, only the regime existing between 2,200 and 2,500 Reynolds' numbers in the present system showed the ordinarily accepted criteria of critical flow. Nevertheless, as both the regions between 1,000 and 2,200 and between 2,500 and 5,000 fall outside the laws of either viscous or turbulent regimes, they are treated here as 'pre-critical' and 'post-critical' regimes.

In the accompanying graph, the corrected head lost per unit length of pipe is plotted against the average linear velocity of the water in the pipe, for values of Reynolds' numbers ranging between 240 and 2,800 approximately. It is seen that there are four distinct sections of the curve.

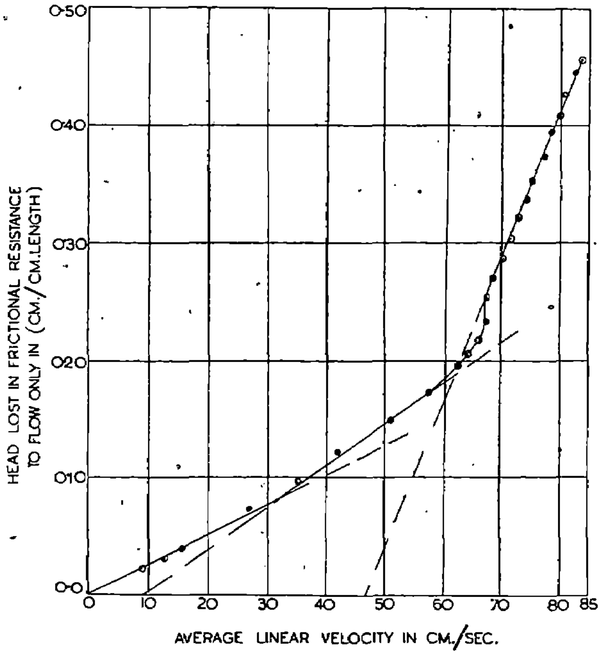
(1) Up to *circa* 1,000 Reynolds' numbers, the ordinary straight line of the viscous regime obtains, characterized by (*a*) passing through the origin, and (*b*) by its slope being governed solely by the viscosity of the fluid in so far as the properties of the fluid are concerned.

(2) Between 1,000 and 2,200 Reynolds' numbers approximately, a second straight line obtains. This straight line differs from the first in that (*a*) it does not pass through the origin; (*b*) it has a higher value for its slope than the first line.

(3) Between Reynolds' numbers of 2,200 and 2,500 approximately, the curve rises almost vertically upwards in the direction of the pressure loss. It is in this and the following region that it becomes essential to eliminate all disturbances from the entry. As mentioned above, strictly speaking this is the critical region.

(4) Between 2,500 Reynolds' numbers and about 5,000, above which the curve shows a definite curvature characteristic of the turbulent regime, there is yet another straight line. The graph goes up to 2,800 only, but other experiments showed that curvature begins above 5,000. This straight line again does not pass through the origin, and it has a steeper gradient than both the viscous and 'pre-critical' lines.

Another important point in connexion with these lines, which is not evident from the graph, is that in the critical region a change of 25 per cent in the viscosity of the flowing water appeared to have no effect on the position or slope of the lines, especially the 'post-critical' curve. Of course, the viscosity is of paramount, but indirect, importance, in that it influences the type of regime obtaining in the pipe.



Thus, it appears that the classification of flow as viscous, critical and turbulent is an over-simplified system. In unpublished work carried out in this Department and to which reference has already been made[1], it became evident that when flow is at extremely low rates, in a medium of high specific surface, such as might obtain in the flow of fluids through porous strata in oil, gas or water production, then the law of frictional resistance due to flow did not follow the laws of the viscous regime. In other words, a 'sub-viscous' or 'pre-viscous' regime of flow appears to exist. Flow then adopts the viscous regime when the velocity is increased, and as is seen here, passes through an intermediary type of flow before it enters the critical regime. Before entering the fully turbulent type of flow, it passes through still another distinct type, the post-critical regime. At extremely high Reynolds' numbers the flow becomes further complicated by the production of certain sound waves.

A final point of interest here is the possibility of using the vertical section of the graph in the production of accurately constant rates of flow in instrumental and process controls, as a very great change is required in the overall head loss to produce a small change in the rate of flow.

It is hoped to publish a fuller report than this elsewhere.

ALFRED H. NISSAN.

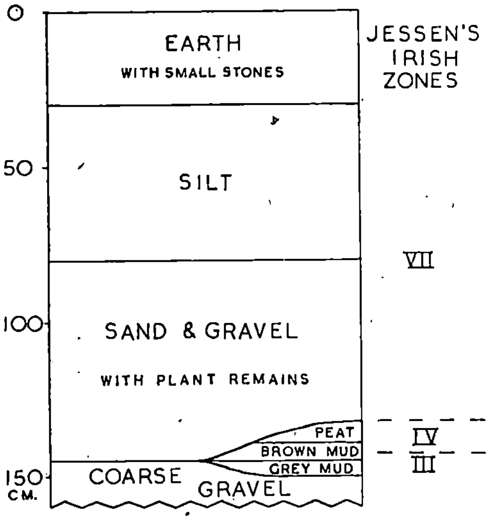
Department of Oil Engineering and Refining,
University, Birmingham, 15.

[1] Nissan, A. H., NATURE, 148, 503 (1941).

A Late-Glacial Flora in Co. Monaghan, Ireland

IN 1715 the molar teeth and other remains of a mammoth were discovered to the east of Belturbet, Co. Cavan[1]. In 1940 a site in the townland of Drumurcher, Co. Monaghan, where near a mill there was a small alluvial flat, was tentatively identified as the place of the original find.

The alluvial flat, which lay between a ridge of rock and a drumlin, was covered by a layer of earth and small stones, certainly disturbed. Under the earth was a layer of sandy silt and below this was a fine river gravel rich in plant debris, including many Corylus nuts and some tree stems. Little pollen of the pine but abundant pollen of the alder was found in the silt and the gravel. These deposits should, therefore, have been laid down after the beginning of Jessen's Irish Zone VII[2]. In places the gravel rested on a fine-grained peat rich in Salix leaves and containing also remains of Betula spp., Potamogeton spp., Carex spp., *Scirpus lacustris*, etc. Only pollen of the birch, pine and willow was found in the peat; it should, therefore, belong to Jessen's Irish Zone IV. Downwards the peat passed over into a brown mud; this in turn became grey in colour and rich in sand. The grey mud rested on a coarse river gravel without plant remains; the bottom of the gravel was not reached. In the muds, tree pollen was very scanty. In places the upper gravel lay on the muds or directly on the lower gravel. The stratigraphy, which is illustrated in the diagram, agreed with that outlined in the original description.



The grey mud was rich in plant remains, among which the following plants were noted—Arenaria spp., *Armeria vulgaris, Dryas octopetala, Oxyria digyna, Salix herbacea* and *Thalictrum alpinum. Dryas octopetala* excepted, all these plants were previously found in a solifluxion deposit at Ballybetagh, Co. Dublin[3]. With this deposit, associated with a local glaciation in the Wicklow Mountains[4], the grey mud at Drumurcher is presumably contemporaneous. The Drumurcher site is about three hundred feet above sea-level. The presence of the small-leaved arctic form of *Dryas octopetala* in Co. Monaghan supports Jessen's suggestion that these Irish late-glacial deposits may be contemporaneous with the upper Dryas clay of Denmark. Though no traces of mammoth were found in 1940, the resemblance of the flora of the grey mud to that associated with mammoth remains at Borna[5] is worth noting.

Thanks are due to Mr. J. Andrews, the tenant of the site, for his co-operation, and also to Mr. A. Farrington and Mr. A. M. Gwynn for their assistance in the field. The work was made possible by a grant from the Royal Irish Academy, in the *Proceedings* of which a full report will be later published.

G. F. MITCHELL.

Iveagh Geological Laboratory,
Trinity College,
Dublin.
March 31.

[1] Nevile, *Phil. Trans. Roy. Soc.*, 29 (1715).

[2] Mahr, A., *Proc. Prehist. Soc.*, Paper 11 (1937).

[3] Jessen, K., and Farrington, A., *Proc. Roy. Irish Acad.*, B, 44 (1938).

[4] Farrington, A., *Proc. Roy. Irish Acad.*, B, 42 (1934).

[5] Weber, C. A., *Abhandl. Naturwiss. Ver. Bremen*, 23 (1914).

Russian for Scientific Workers

THERE must be many scientific workers who would like to learn Russian if facilities were available, and there are certainly some excellent schools of Russian in Great Britain which would offer facilities. The most useful course would be one which would enable a student to read a Russian scientific paper with the aid of a dictionary and not too great an expenditure of time: on a foundation of this sort, a fuller and more general knowledge of the languag could, if circumstances permitted, be developed.

The School of Slavonic and East European Studie of the University of London is making a start with a beginners' class open to any student, and as an act of marked generosity, given without fee to persons employed by the University or its institution in teaching or administrative posts. Other course are arranged elsewhere.

The purpose of this letter is to ask whether ther are groups of scientific workers who would like t learn Russian, if the necessary arrangements coul be made. There seems little doubt that the teachin could be provided in many cases at least, and if on knew the extent of the unsatisfied demand, it wou be possible to set about meeting it. I should welcom any suggestions or comments.

E. J. RUSSELL.

Ministry of Information,
Malet Street,
London, W.C.1.

X-RAY ANALYSIS IN INDUSTRY.

X-RAY analysis provides a new tool for solving industrial problems. It is used in many laboratories in Great Britain, and the researchers who have become expert in handling it are constantly developing new methods, and discovering new types of problem to which it can be successfully applied. The Conference arranged by the Institute of Physics, and held at Cambridge on April 10 and 11, had as its object the interchange of ideas and knowledge between the various groups of workers. Two previous attempts to call this Conference have been frustrated, the first by the onset of war and the second by the difficult conditions of the summer of 1940. In order that the object which it had in view might at any rate be partially achieved, the Institute of Physics decided to publish the series of papers which appeared in the *Journal of Scientific Instruments* in May and July 1941; these papers formed the basis of discussions for the present Conference. Some anxiety was felt by those responsible for the arrangements, lest preoccupation with war-work would prevent many from attending, but the decision to proceed was made because the X-ray tool is being widely used for problems directly connected with the War. The large attendance at the Conference (some 280 participated) and the generally expressed appreciation of this opportunity for discussion have shown that this anxiety was unnecessary.

X-ray analysis found its earliest application in the study of crystalline structure, the pattern of the atomic arrangement in the perfect crystal. The results of this analysis have had a profound influence on fundamental concepts of the nature of chemical combination. It has been realized that the law of combining proportions is not always the result of the grouping of atoms into molecules; in many classes of compound it represents the ratio of the numbers of atoms which are welded by the interatomic forces into one continuous pattern. It has been realized that one must be cautious in carrying over into the metallic field concepts based on organic and inorganic compounds, and the physical realities behind such terms as 'intermetallic compound', 'phase', and 'solid solution' have become much clearer. Such work ultimately influences technical applications, because it clarifies ideas.

The Conference concerned itself, however, with more direct applications of the X-ray method, and the subject of crystal analysis was specifically excluded, or rather, its results were taken for granted. An actual crystalline material may be composed of fragments with different types of crystalline structure. The crystallites have characteristics of size, of shape, of orientation, and of perfection, which may profoundly modify the macroscopic properties of the material. The perfect pattern is an ideal only attained by crystals under special conditions. In 'mixed crystals' various atoms may serve as proxies for each other, and an increasing number of crystals are proving to be tolerant to a remarkable extent of minor variations in their pattern without destroying its general plan. X-ray analysis affords valuable information about their characteristics, and is often the only available method of attack; the study of such problems was the business of the Conference.

The progress of an X-ray analysis is reminiscent of that in a good detective story. It is an indirect method. We cannot extort a full confession from the guilty party. Instead, we are given a series of clues, which point to some possibilities and exclude others, until finally we have an accumulated weight of evidence which makes us confident we have arrived at the right solution. The indirect nature of the evidence is seen most clearly in the analysis of crystalline patterns. Theoretically, the observed X-ray diffraction effects might be produced by an infinity of arrangements of scattering matter (in technical terms the phases of the scattered beams are not observable). A unique solution is only possible because other evidence can be called in support. The right solution must represent atoms of known number and type, with features of arrangement and spacing relative to each other which previous experience with other structures has shown to be characteristic. Instead of logically deducing a solution, intelligent guesses have to be made and tested against the observations. The same is true for X-ray analysis of all types. The clues afforded by the more or less diffuse spots, arcs, or lines on an X-ray photograph of some mysterious material must be combined with a wealth of other knowledge if they are to be followed up. Much of the fascination of X-ray analysis is due to its taking one into so many other fields of science. The X-ray expert should not only understand the optical principles on which his science is founded; he must at the same time be a chemist, a metallurgist, a petrologist, or a biochemist. The optical principles can be logically deduced, but imagination, common-sense and a wide general knowledge lead him to make his intelligent guesses.

The wide range covered by the industrial applications is shown by the papers published last year. In the short time available at the Conference detailed discussion of all the papers was not practicable, and it was decided to group certain of the papers together and discuss them under the three headings: "Cameras for X-ray Analysis"; "The Application of X-ray Crystallography to Industrial Problems"; "X-ray Structure and Mechanical Properties". At the same time an exhibition of photographs, films and apparatus cognate to the above subjects was arranged. This exhibition was well supported, and examples of recent work and modern apparatus emphasized the very marked improvements in technique which have taken place in the last decade.

The papers, and the contributors to the discussion at the Conference itself, all came from laboratories in Great Britain. They did not represent a general review of the application of X-ray analysis to industrial problems, which has been advanced by workers in many countries. The limitation was deliberate. The Conference was planned to be a comparing of notes and pooling of knowledge by the many X-ray workers in Great Britain who desire to collaborate more closely, and it has done much to further this aim.

In each discussion the procedure adopted was that the main aspects of the subject were introduced by speakers who had contributed papers to the symposium, and afterwards a general discussion took place. This present account of the proceedings deals only with the more interesting items arising from the general discussions.

On cameras, two interesting developments may be mentioned, one by Orowan of the Cavendish Laboratory, Cambridge, describing the use of a rotating wire grid which enables much extra useful information to be obtained from rotating crystal photographs, and the other by Frommer of High Duty Alloys, Slough, concerning the design of very large cameras in which completed metallurgical products can be examined for measurement of internal stress.

The discussion on applications brought out the very great diversity of subjects now being investigated by X-ray methods. Bunn of Imperial Chemical Industries, Ltd. (Northwich), in his remarks emphasized the need for the production of an index of the known structures of chemical compounds, etc., as this would be a great help in the identification of compounds. This question was the subject of further comment by other speakers, and was referred to the organizing committee of the Conference with the view of promoting active steps to provide an index for X-ray workers.

The final discussion was concerned with the correlation of X-ray structure of metals and mechanical properties. Numerous speakers indicated how industry is developing this subject in connexion with such problems as the measurement of internal stresses and preferred orientation in strip and wire, and on the theoretical side Sir Lawrence Bragg showed how the measurements by Wood on the limiting crystallite size of metals can be used to estimate in a simple way their yield strength within very reasonable limits.

On April 10, Sir Lawrence Bragg delivered a lecture entitled "The History and Development of X-ray Analysis." This was a very enjoyable feature. It commenced with a fascinating account of the early work of himself and his father, the late Sir William Bragg, and after tracing the major developments up to the present time, ended with a statement of various problems, such as the structure of proteins, the 'fine' structure of deformed metal, etc., which were in his opinion on the threshold of solution.

As a result of the interest displayed at the Conference and the enthusiasm of the members, a resolution was passed suggesting that the organizing committee should take steps to set up a permanent organization under the ægis of the Institute of Physics to arrange similar conferences from time to time.

CRYSTALLINITY IN CELLULOSE ESTERS

According to an article by W. O. Baker (*Bell Lab. Rec.*, 20, No. 6, Feb., 1942) the toughness, strength and flexibility of plastics are influenced by the arrangement as well as the composition of their giant molecules. In an endeavour to discover the fundamental properties of certain compounds such as cellulose acetate and cellulose butyrate, which make these materials resistant to shock, bending, twisting and dimensional change, studies were undertaken on a molecular scale, the high magnification necessary being obtained by photographing X-ray beams after passage through selected samples of the plastics. These photographs give patterns which can be measured to show molecular distances as small as a billionth of an inch; and they also indicate how the molecules are placed with respect to each other.

A minute cylindrical beam is passed through small flat sections about one millimetre thick, much of it expanding into coaxial cones on account of diffraction by the layers of molecules. After an exposure of three or four hours, circular records appear on the photographic film, the degree of crystallinity being indicated by the sharpness and number of circles recorded. In striking analogy to metals, it was found that the cellulose esters could be quenched by rapid cooling from the molten state. The long polymer molecules were then found to be disordered with respect to each other. Neighbours of a given molecule are quite randomly arranged although there is a tendency for sections of the chains to lie side by side. When cooled slowly, however, the molecules have a very ordered arrangement in local regions throughout the plastic. When they have the maximum disorder, the material tends to be most soft and flexible, and when they are most ordered, or crystallized, it is hardest and strongest, but sometimes brittle.

Two other methods of controlling the number of organized and disorganized molecules have long been used as working procedures in the technology of cellulose plastics. The first is to control the shape of the cellulose ester molecules by the amount of the reaction and the nature of the substituting groups so that they can only partially fit together, to give an ordered arrangement. The second, applying chiefly to lacquers such as aeroplane dopes and film formation, is the selection of a particular solvent which evaporates as the cellulose ester film dries. Various liquids were found to cause different amounts of molecular disorder in the resulting films.

The study showed that sections of the plastic's molecules could orient themselves in an ordered position in the solid state and that they undergo considerable torsional motion under the influence of temperature. Thus, it was possible to anneal quenched cellulose esters, and X-ray patterns show how this process causes the chain molecules to take up ordered positions. This ability of molecules to move in plastic solids even at ordinary temperatures appears to be closely related to their plasticity and capacity to bend and return to original form.

DEVELOPMENTS IN ADULT EDUCATION*

By DR. BASIL A. YEAXLEE

University of Oxford

Despite all that has been done in the field of educational psychology adult education has still only an empirical basis. There has been practically no research in Great Britain and very little in the United States. Yet without such careful inquiry it is not possible to plan effectively the great extension of the movement that is desirable after the War or to develop the necessary variety of methods. The first stage is to determine the problems to which the attention of psychological investigators should be directed. The educational activities now so widespread among men and women of H.M. Forces should yield valuable data and suggestions.

It must be remembered that nothing like simple extension into this constituency of work on conventional lines was feasible. The opportunity was, and is, immense. But conditions as a rule prevent the systematic, continuous study and the maintenance of academic standards which characterize the courses and classes carried on among civilians in peace-time by university extra-mural departments and organizations such as the Workers' Educational Association. On the other hand, a very small percentage of the population is normally reached by these activities, and a great deal of genuine adult education has been and always must be unorganized. The Central Advisory Council for Adult Education in H.M. Forces, however, which through its twenty-three regional committees makes the civilian resources of the country in lecturers and teachers available to the Services, now reports not only a constantly growing number of single lectures but also a gratifying increase in the demand for short courses*. An extract from one lecturer's diary runs: "The course which never ends: now on Course III, Lecture 8—or something like that: gave a talk on three famous Concertos, the Tchaikovsky, Grieg, and Addinsell's Warsaw Concerto." Another lecturer's report refers to the "widespread evidence of a new sensitiveness to political and economic issues on the part of the average soldier". This lecturer also says: "The mood is sometimes cynical, but more often it is shrewd, positive and percipient, quick to question glib assumptions and assurances, unafraid to seize upon often disconcerting comparisons, but eager to be informed, convinced and reassured on the grave questions that abide the issue of their day."

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* Substance of an address to the Education Section of the Britis Psychological Society at its Extended General Meeting, Brighton April 10, 1942.

Adult education among members of the Forces, as among civilians, relies upon the interest of the student. There is no prescribed curriculum, as in schools and universities. Attendance is voluntary, if it is in leisure time, as this work is intended to be. Facilities are open to all. It has been said, however, that of course only some 20 per cent of the troops are in the least likely to avail themselves of these, since that proportion can be safely taken as the maximum number of people who show any interest in adult educational activities, whether cultural or vocational, in civil life. If this proves even approximately true, however, it reflects more upon what is offered than upon those who ignore or reject it. We cannot be content to believe that 80 per cent of men and women are completely devoid of cultural interests because they are unattracted by lectures and discussions on topics which appeal to he 'intelligentsia'. The question for the psychologist s whether adult education has not been too much limited to intellectual interests. He must indeed ask also whether school and college education has been o intellectualist or so utilitarian that average people misunderstand the very word education and do not dream of connecting it with the word adult, or with life as they have to live it.

The rapidly extending practice of arts and crafts y men and women in the Services is one of the actors in the present great experiment that may be f greatest importance in the future development of adult education. It has been said by some that music, drawing and painting and recreative handicrafts have no place in a war-time scheme of adult education because, in their view, these have no rela-on to the serious business of understanding either he causes and issues of the world conflict which now emands the exercise of all our mental and physical nergies or the aims and conditions of social and olitical reconstruction when victory has been won. he majority, however, would not agree. For in uch occupations men and women are neither escapist nor inclined to fiddle while Rome is burning. They are discovering that they have creative imagination and constructive capacity. The importance of this not only educationally and psychologically but also sociologically is all the greater at a time when thousands of men and women are making closer acquaintance than ever before with what mechanization means. It is on this side much more than on the more academic that they are finding new interests, and achieving that greater completeness and balance of personal development which are so greatly needed if human society is not only to recover from the cataclysm of war, but also to approximate more nearly to the good life.

Educational activities among the women's Services are not so extensive as among the men. This is partly due to the fact that hitherto they have not had their own education officers and organization. That deficiency is being remedied. The Director of Army Education now has an A.T.S. officer with the necessary training and experience attached to his staff at the War Office, and soon there will be a similar appointment in each Command. Action has also been taken by the W.R.N.S. and W.A.A.F. Directorates. It is important to note this because the expansion of the Army Educational Corps at once produced a much greater volume of educational demand and experiment among the men, and doubtless the same will happen in the case of the women. But in all probability the women's needs and desires, understood by their own education officers as even the most sympathetic of men cannot be expected to understand them, will not be merely for 'domestic' subjects and 'feminine' activities. They will want many of the same things but will approach them from a different aspect. What the educational psychologist should be finding out is how far it is true that, contrary to popular notions, women are the more practical in their thinking and men the more abstract and theoretical. The two, of course, are complementary. Men and women in the Services share educational activities to an increasing extent. But when women are drawn in much greater numbers into participation in the scheme, many will want programmes of their own. It would be a great pity and a serious loss if now and after the War 'women's interests' in adult education were misconceived, and if attempts to make special provision for them failed correspondingly.

It has been found that women are more inclined than men to seek pure relaxation in their off-duty hours, especially in the evening when the day's work is done. This raises another psychological question —the nature and reciprocal effect of physical and mental fatigue. That men and women work equally hard there is no doubt. But it is probable that a far larger proportion of women than of men are engaged on monotonous duties very similar to some aspect of their peace-time employment. For the greater number of men, joining one of the Services means learning how to do a considerable variety of things which are new to them and several of which usually come into the same day's work. Physically, women often have more endurance than men, though less brawn and muscle. The fatigue they exhibit—or at least the inclination to seek amusement rather than education after a hard day's work—may well be due to monotony rather than to physical exhaustion and may well be more mental than physical. A study of this would be of value in considering what forms of adult education should be promoted when peace-time conditions of work and leisure are restored. In this connexion again it is worth while to remember what great use the U.S.S.R. has made in adult education of the arts—films, music, the theatre, opera and so forth—as well as of physical training and open-air sports.

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*The figures for the six months April 1–Sept. 31, 1941, which will greatly exceeded by those for the ensuing winter half-year, are ,983 single lectures, 1,530 short courses, and 1,075 classes arranged rough the agency of regional committees. These do not include al education authority classes or lectures and classes arranged ernally by the Services themselves, using their own personnel. CA is of course an independent activity, all talks being given and cussions conducted by regimental officers in parade times.

There are two tensions to be maintained in adult education. One is between amusement and educational seriousness. Adult education must be recreative and at the same time must not lose real educational content and quality. The other is between emotional states and intellectual effort. There is always a tendency, as war goes on, to take more and more the attitude *delenda est Carthago*, but this results more from a cumulative feeling than from reasoned judgment. World reconstruction will demand discrimination of a kind incompatible with hatred. There has been a considerable degree of spontaneous refusal to accept Vansittartism, but all the time there is a tendency to drift into precisely that state of rationalized hatred and aggressiveness. Similarly the increase of propaganda, of however legitimate and truth-telling a kind, begets a tendency to scepticism and a temper of suspicion. Thus, for example, the unvarnished account by a German refugee of his experiences in an internment camp was received with incredulity by men who assumed that it was rather a blatant attempt to whip up their 'morale'. Years ago, Mr. Walter Lippman warned us of the universal tendency to judge everything by "the picture in the mind". If the problems of democracy and of a planned society after the War are to be solved happily and with reasonable speed, adult education, now and then, must both evoke and sustain the power of imagination and equally train the critical judgment.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk is open to the public*)

Wednesday, May 6

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. J. C. Drummond: "War-Time Nutrition and its Lessons for the Future".

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Post-War Planning in Radio Communication" (to be opened by Colonel Sir A. Stanley Angwin and Mr. H. Bishop).

Thursday, May 7

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Annual General Meeting. 6.30 p.m.—Adjourned Discussion on "A Critical Review of Education and Training for Engineers", by the Education and Training and Personnel Sub-Committee.

Friday, May 8

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Kendall, F.R.S.: "The Separation of Isotopes and Thermal Diffusion".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HORTICULTURAL DISTRICT OFFICER in South-East Norfolk—The Secretary, Norfolk War Agricultural Executive Committee, Sprowston, Norwich (May 8).

UNIVERSITY CHAIR OF OIL ENGINEERING AND REFINING (PETROLEUM TECHNOLOGY)—The Secretary, The University, Edmund Street, Birmingham 3 (May 9).

UNIVERSITY READERSHIP IN ORGANIC CHEMISTRY tenable at London (R.F.H.) School of Medicine for Women—The Academic Registrar, University of London, Richmond, Surrey (May 12).

LECTURER IN MECHANICAL ENGINEERING SUBJECTS—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (May 16).

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Table of Squares of all Numbers less than 300. 9 in. × 6½ in
(London: Scientific Computing Service, Ltd.) 1*s*. [13

China To-day: the Thirtieth Anniversary of the Chinese Republic
1911–1941. Pp. 55. (Cambridge: Central Union of Chinese Student
in Great Britain and Northern Ireland.) [13

Thirty-ninth Annual Report, 1941–1942, of the Imperial Cance
Research Fund. Pp. 32. (London: Royal College of Surgeons.) [13

Report of the Rugby School Natural History Society for the Yea
1941. (75th Issue.) Pp. 24. (Rugby: George Over (Rugby)
Ltd.) [13

Quarterly Journal of the Royal Meteorological Society. Vol. 6
No. 294: The Phenological Report, 1941. By Major H. C. Gunto
Pp. 89–119. (London: Royal Meteorological Society.) 3*s*. [17

Other Countries

American Philosophical Society. Year book 1940, January 1, 1940
December 31, 1940. Pp. 466. (Philadelphia: American Philosophic
Society.) [13

Smithsonian Institution: United States National Museum. Bulleti
100: Contributions to the Biology of the Philippine Archipelago an
adjacent Regions—The Fishes of the Groups Elasmobranchii, Hol
cephali, Isospondyli, and Ostarophysi obtained by the United Stat
Bureau of Fisheries Steamer *Albatross* in 1907 to 1910, chiefly in t
Philippine Islands and adjacent Seas. By Henry W. Fowler. P
x+879. (Washington, D.C.: Government Printing Office.) 1.2
dollars. [13

Proceedings of the United States National Museum. Vol. 89, N
3096: The Cuban Operculate Land Mollusks of the Family Ann
lariidae, exclusive of the Subfamily Chondropominae. By Carlos de
Torre and Paul Bartsch. Pp. 131–386+x+plates 9–57. (Washingto
D.C.: Government Printing Office.) [1

U.S. Department of the Interior: Geological Survey. Bullet
883–B: Spirit Leveling in Texas, Part 2: Panhandle, 1896–193
Pp. ii+51–149+1 plate. 15 cents. Bulletin 900–F: Subsurfa
Geology and Oil and Gas Resources of Osage County, Oklahom
Part 6: Township 28 North, Ranges 10 and 11 East, and Township
North, Ranges 9 to 11 East. By H. B. Goodrich, L. E. Kennedy a
Otto Leatherock. Pp. iii+209–236+plate 6. 50 cents. Bulletin 906–
Structural Control of Ore Deposition in the Uncompahgre Distri
Ouray County, Colorado. By W. S. Burbank. (Contributions
Economic Geology, 1938–39.) Pp. iv+189–265+plates 53–54.
cents. Bulletin 922–L: Quicksilver Deposits of the Mayacmas a
Sulphur Bank Districts, California. A Preliminary Report by C.
Ross. (Strategic Minerals Investigations, 1940.) Pp. iii+327–353
plates 47–53. 45 cents. Bulletin 922–N: Chromite Deposits of t
Eastern Part of the Stillwater Complex, Stillwater County, Monta
By J. W. Peoples and A. L. Howland. (Strategic Minerals Investi
tions, 1940.) Pp. iv+371–416+plates 63–65. 40 cents. Bulle
922–Q: Tungsten Deposits in the Tungsten Hills, Inyo Coun
California. By Dwight M. Lemmon. (Strategic Minerals Investi
tions, 1940.) Pp. iii+497–514+plates 72–77. 20 cents. Bulle
922–S: Tungsten Deposits of the Benton Range, Mono County, Ca
fornia. By Dwight M. Lemmon. (Strategic Minerals Investigatio
1940.) Pp. iii+581–593+plates 88–89. 30 cents. Bulletin 925–
Geophysical Abstracts 100, January—March 1940. Compiled by
Ayvazoglou. Pp. ii+50. 10 cents. (Washington, D.C.: Governm
Printing Office.) [1

U.S. Department of the Interior: Geological Survey. Wat
Supply Paper 870: Summary of Records of Surface Waters of Wa
ington, 1919–35. Pp. vi+456+7 plates. 65 cents. Water-Sup
Paper 881: Surface Water Supply of the United States, 1939, Part
Pacific Slope Basins in California. Pp. xii+446+2 plates. 75 ce
Water-Supply Paper 884: Surface Water Supply of the United Sta
1939, Part 14: Pacific Slope Basins in Oregon and Lower Colum
River Basin. Pp. vii+220+1 plate. 30 cents. (Washington, D.
Government Printing Office.) [

Smithsonian Miscellaneous Collections. Vol. 101, No. 8: Bees
the Family Hylaeidae from the Ethiopian Region. By T. D. A. Co
erell. (Publication 3649.) Pp. ii+15. Vol. 101, No. 9: Notes
some American Fresh-Water Amphipod Crustaceans and Descripti
of a New Genus and two New Species. By Clarence R. Shoema
(Publication 3675.) Pp. ii+31. (Washington, D.C.: Smithso
Institution.) [

Proceedings of the United States National Museum. Vol. 91,
3122: A New Fossil Crocodilian from Colombia. By Charles
Mook. Pp. 55–58+plates 4–9. (Washington, D.C.: Governm
Printing Office.) [

U.S. Department of the Interior: Geological Survey. Professi
Paper 193–D: Some Structural Features of the Northern Anthra
Coal Basin, Pennsylvania. By N. H. Darton. (Shorter Contribution
General Geology, 1938–39.) Pp. iii+69–82+plates 10–19. 50 cents.
fessional Paper 194: The Gold Quartz Veins of Grass Valley, C
fornia. By W. D. Johnston, Jr. Pp. vi+102+39 plates. 2.50 doll
(Washington, D.C.: Government Printing Office.) [

Government of Iraq. Ministry of Defence: Meteorological Ser
Annual Report of the Director, No. 5, Year ending 31st March 1
Pp. iii+14. (Baghdad: Government Press.)

Carnegie Institution of Washington. Year Book No. 40, Jul
1940—June 30, 1941, with Administrative Reports through Dece
12, 1941. Pp. xxxii+346. (Washington, D.C.: Carnegie Ins
tion.) 1 dollar. [

Bulletin of the Experiment Station of the Hawaiian Sugar Plan
Association. Agricultural and Chemical Series, Bulletin No. 53:
and Plant Material Analyses by Rapid Chemical Methods, 3.
Francis E. Hance. Pp. 265–296. (Honolulu: Hawaiian Sugar Plan
Association.)

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ORGANIZATION OF PRODUCTION

THE interest with which the recent debate in the House of Commons on production was followed indicates how thoroughly the importance of the issues is understood in Great Britain, and the anxiety that there shall be no further weakness in either administration or in policy. The limitations of man- and woman-power, and also of materials, are much too severe for there to be complacency over waste either through individual slackness at the level of the operatives or through inefficiency at that of management. The speech made by Mr. Oliver Lyttelton as Minister of Production was clear and encouraging. He has an exact notion of what is to be accomplished, and he made the new arrangements sound more reasonable than they did in the Prime Minister's formal announcement.

The Minister of Production faces three major tasks. One is to ensure that the domestic production programme of Great Britain is both balanced and efficient. The second is to integrate it with the programmes and needs of the other united nations, and particularly with those of the United States. The third is to ensure "a complete fusion between military plans and thought and production plans and thought", not only in the realm of strategy, but also in that of battle tactics. It is this task, probably the most urgent, that has for some time been the special concern of scientific workers. It has been the burden of conferences arranged by the Association of Scientific Workers on science and the war effort. It was voiced by Sir Henry Tizard at the annual luncheon of the Parliamentary and Scientific Committee, and it was the main theme of Prof. A. V. Hill's long speech in the House of Commons on the war situation on February 24.

Mr. Lyttelton's statement that to accomplish this purpose there is to be what he described as a general staff of war production goes some way to meet Prof. Hill's plea for a general staff with executive functions, including a full-time technical section of able officers of all arms who have grown up with modern weapons and equipment, to deal with the general strategy of the War. The body described by Mr. Lyttelton is designed to be an exact parallel to the Chiefs of Staff Committee on the military side. It will consist of his Chief Adviser on Programmes and Planning, Sir Walter Layton, the assistant chiefs of staff of the three Services, together with the highest technical officers of the three Production Ministries, and will be the servant on war production matters of the Defence Committee.

The Joint War Production staff will be served by a Joint War Production Planning Group concerned with the planning of what is to be produced, and composed of Navy, Army and Air Force officers and representatives of the Production Ministries working together in the same office. These proposals forestall some of the recommendations in the Eighth Report of the Select Committee on National Expenditure, dealing with the organization of production, which has since appeared, particularly those relating to a balanced plan, to an adequately staffed

Intelligence and Programmes Branch, and to the examination as a matter of urgency of means of formulating with precision, and so far as possible in advance, the demands of the Fighting Services. The Joint War Production Staff with the Programmes and Planning Division will work in close touch with, and supply information required by, the combined Anglo-American organization. Arrangements are being made to include a study of the war production and requirements of the Empire, and Mr. Lyttelton was at pains to stress that the object of the new organization is to ensure that production is closely and continuously related to strategical requirements as well as battle tactics.

This section will be in the charge of Sir Walter Layton, and will also be intimately concerned with such combined problems facing the United Nations as the dovetailing of the British supply of raw materials and British manufacture of munitions into the programme of the United States. A special Raw Materials Division will deal with general policy on the development of raw materials, on the control of import of raw materials, the allocation and releases of stocks of raw materials, with an Empire clearing-house and with the relations between the British Raw Materials Committee and the committee in the United States which deals with the combined raw material requirements and supplies of the United Nations. A further Production Division will be a small technical division in the charge of an industrialist with wide general experience. To him will be attached a technical officer from each of the three Production Departments, so that the closest touch will exist between the Production Division and the Department. The main functions in the industrial field of this Division will be those subjects which affect all three Production Departments simultaneously.

Mr. Lyttelton will address himself particularly to the problems of steady production in the face of changes in the enemy's strategy, in the geographical theatres of war, the accession of new allies, the appearance of new enemies, and the interruption of sources of raw materials, which may oblige us to substitute one type of munition for another. Moreover, he recognizes the importance of relieving the natural concern and anxiety of workers who may find idle time on their hands from such causes. The new Minister of Production is clearly resolved to see that enforced idleness, whether it springs from the loss of shipping carrying essential supplies, the necessity of substituting a new type on a sudden message from the battle-front, or delay or destruction due to enemy air attack on factories or communications, does not become the breeding-ground of suspicion and misgiving.

The importance of taking the workers into the Government's confidence in this respect, in order to achieve the extra production and with it the aggressive spirit in industry as well as in the Fighting Services, is not easily overstressed. It will go far to eliminate the bad discipline which is another source of inefficiency, and in itself it should be a spur to more efficient management where required. Mr. Lyttelton promised that no defects will be glossed over, and that where something is proved to have been wrong, such measures as are possible will be taken to put it right.

Mr. Lyttelton said little himself about management efficiency, but the whole tone of his speech implies that he is prepared to countenance disciplinary action against management as well as against worker where required. There is already the precedent of the War Agricultural Committees in dealing with inefficient farmers, and if similar measures were applied to the managements of workshops or factories where required, and in backward establishments there were enforced those simple rules upon which the health and efficiency of labour so largely depend, much would have been done to remove suspicion of unfairness and to create the conditions for effective team-work upon which so much depends. The new Regional Division, the most radical change announced by Mr. Lyttelton, is an attempt to raise the standard of organization of production among the many smaller firms, and like the works committees, will depend for its success largely upon such a spirit of co-operation. Local organizing ability will be given a chance to show itself, just as the works committee can be used as a clearing-house for explanations and suggestions and for levelling up practice in all the shops of one trade.

But team-work must be forthcoming from more than the workers and the factory management. Mr. Greenwood's observation that in the past there has not been the full team-work and co-operative spirit in the Production Departments without which maximum effort is not possible should be taken to heart at the very top as well as at the bottom. In this connexion the Seventh Report of the Select Committee on National Expenditure, which has since appeared, points out that so far the organization o labour supply has not been undertaken with tha breadth of conception and firmness of execution whic are necessary for the creation of our maximum militar strength. The Minister of Production's spirit o co-operation and open mind must be widely shared i we are to solve all the difficult strategic problems o production and of man- and woman-power, perhap especially those involved in the increasing use o women in industry and the exploration of the use o part-time labour.

Mr. Lyttelton's clear conception of the power attaching to his office—his supreme authority ove raw materials and over machine tools, and a co ordinate authority over labour—and the machiner which he has superimposed on that already existin interlocking the affairs of the workers with those the fighters, have already engendered high hopes the instrument in his hand. Whether he is to wie it effectively for the destruction of the enemy depen on more than Mr. Lyttelton's own personality an ability. It depends on the support and co-operatio which he receives from the Cabinet downwards, an the more boldly he uses his authority the mo loyally he will be supported.

Organization alone will not secure the full pr duction that is desired, though that is no reason f tolerating inefficient administration, bad management or defective organization. The shortage of efficient administration makes it essential, as Sir John Wardlaw-Milne insisted, to use the large number of men of fifty and above who have wide administrative experience but are largely unused. But to knit Government, management and workers into one harmonious team keyed up to its maximum effort and efficiency, we need a new spirit of aggressiveness.

There may be differences of opinion as to whether that new spirit will spring, at least directly, from the self-interest which Sir John Wardlaw-Milne stressed in this connexion. There is likely to be wider support for Sir William Beveridge's view in his plea for a new spirit in grappling with total war, that if war is to be waged offensively against evil, for the ideals of tolerance, fair play, freedom of thought and speech, kindliness and the value of the individual soul, it must be in the spirit and passion of a crusade, in a spirit of service, transcending the thought of duty alone.

There are few scientific workers who would not respond to Sir William Beveridge's noble plea in his recent article in *The Times* for the casting aside in this time, and for the building of the peace when victory is won, of the obsolete party allegiances and ideals, of profit and of selfish and money-making motives. These are the obstacles to full comradeship and trust, in production as in arms, and Lord Hankey's weighty words on the machinery of government in the House of Lords point to a weakness in government, to which Sir William Beveridge also referred, through the attempt to construct the Government more on the balancing of party considerations than on grounds of national efficiency. Service rather than gain should be the main motive of war effort in Government and in industry as in fighting. There can be no doubt of the response of the nation to great leadership; it is earnestly to be hoped that the new production machinery will be boldly and imaginatively used, that constructive ideas will come from above, and that inspired leadership will kindle a new comradeship and loyalty which shall carry us swiftly to full victory.

MODERN THEORY OF CHEMICAL REACTIONS

The Theory of Rate Processes

The Kinetics of Chemical Reactions, Viscosity, Diffusion and Electrochemical Phenomena. By Samuel Glasstone, Keith J. Laidler and Henry Eyring. (International Chemical Series.) Pp. ix+611. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 42*s*.

PHYSICAL chemistry started with van t' Hoff's discovery (1884) of the reaction isochore, which, fundamentally, stood on the same ground as the gas theory of Maxwell and Boltzmann. In the field of reaction rates the ideas of this period produced the mass action law of Guldberg and Waage and the exponential equation of Arrhenius.

Planck's quantum theory (1900) led to a new departure in physical chemistry. Its application to thermodynamics resulted in the third law, which defined in principle the position of chemical equilibria in absolute terms. There occurred, however, no corresponding progress in the field of reaction rates; in fact, for the time being, the nature of chemical change became rather more obscure. Between the classical Maxwell-Boltzmann view of atoms in perpetual motion passing continuously through every conceivable configuration, and the rigid set of stationary states postulated by quantum theory, there was an essential contradiction which paralysed, rather than stimulated, inquiries into the ways by which atoms can pass from one molecular partnership into another.

Quantum mechanics opened a third phase of physical chemistry, in which the theory of reaction rates received a new stimulus. Heitler and London's theory of the electron-pair bond and London's treatment of the three-electron and four-electron problem gave a general— though to begin with naturally somewhat crude—conception of the way in which atoms may become engaged and disengaged in the course of chemical reactions. Since 1929 a steady development has been going on from this starting-point, in which the work of H. Eyring has played the most important part. "The Theory of Rate Processes" was written, as the introductory chapter tells, in the conviction that this last phase has now reached some conclusive results. The book is meant to demonstrate this.

We are thus presented here with a survey which attempts a synthesis of many single contributions in the light of one set of propositions. It is an authoritative effort carried out with vigour, skill and profundity, and its result is a unique achievement. There can be no doubt that all future inquirers in the field of reaction theory will have to start by consulting this work.

Yet there remains the question: Does the book, and the work reviewed in it, fulfil the desire for a theory of chemical reactions?

The answer is not simply affirmative. There is no single new law claimed here of the kind of the reaction isochore or the third law. We could predict all chemical reactions, if we could solve the quantum mechanical equations; but that, of course, is a truism. The purpose of the new theoretical apparatus is in fact to find approximate solutions for specific classes of integrals, often circumventing part of the problem by introducing empirical values for terms which cannot be evaluated from first principles. The quasi-empirical method for calculating activation energies, the theory of the activated complex, both in its statistical and its thermodynamical forms, represent a scaffolding by which the general theorems of quantum mechanics can be brought to bear on concrete 'rate processes'. The real question is, therefore, how far they have succeeded in this function.

One claim, I think, can now be made in this respect without much danger of a challenge to the contrary. The modern theory of reaction rates has finally succeeded in establishing itself as an indispensable method of thought. It has become the recognized tool for any detailed speculations in the mechanism of chemical change; in fact for any intelligent appreciation of the subject. I think that in addition to this a good deal of sound semi-quantitative confirmation has also been obtained. But I would hesitate to pronounce on its finality. In many cases we are clearly yet at the stage where we must be satisfied to account for the observed phenomena, without claiming much certainty for our explanation.

I regret that the juncture between the new theory of reaction rates and the 'electronic theory' of Flursheim, Lapworth, Robinson and Ingold still does not seem very close. The future valuation of the new ideas may largely depend on the extent to which they will prove able to explain more of the remarkable rules which the organic chemist has discovered and has not yet related with any degree of precision to the interplay of atomic forces.

In the light of present achievement and in the hope of further advance, we may recall for a moment the general expectations which have been entertained on the subject of theoretical chemistry for the last thirty years or so. It was about 1912 that I first heard it said in jest, that "You need not bother any longer to learn chemistry, because soon it will all be predicted mathematically". I have heard this kind of joke many times since. Meanwhile it seems to become quite clear that chemistry will never become predictable mathematically; and that, in fact, we have rather to make mathematical physics —in a sense—more chemical. We have to discover a set of empirical simplifications—corresponding to the nature of the chemical properties of matter—which will allow us to crystallize the general equations of atomic physics into a form readily applicable to chemical changes. The "Theory of Rate Processes" will long remain a landmark on this line of progress.

M. POLANYI.

PARACELSUS AS PHYSICIAN

Four Treatises of Theophrastus von Hohenheim called Paracelsus

Translated from the original German, with Introductory Essays, by C. Lilian Temkin, George Rosen, Gregory Zilboorg, Henry E. Sigerist. Edited, with a Preface, by Henry E. Sigerist. (Publications of the Institute of the History of Medicine, the Johns Hopkins University, Second Series: Texts and Documents.) Pp. xiii+256. (Baltimore, Md.: Johns Hopkins Press, 1941.) 3 dollars.

"THE most striking figure among the physicians of the sixteenth century, perhaps in the whole of medical history, is Theophrastus von Hohenheim, called Paracelsus (1498–1541)". This is the considered verdict of the best English historian of medicine. Paracelsus died at the age of forty-eight, after a wandering life, part of which was spent in the mining town of Villach, where he not only studied the diseases of miners, but also acquired a knowledge of chemistry. Some three hundred works have been attributed to him, of which one third have been printed and perhaps not more than fifteen are genuine. He borrowed much, without acknowledgment, from Basil Valentine.

A keen student of the natural sciences, but of a wild and violent temper, Paracelsus attacked Galen and the Galenic tradition with unbalanced aggressiveness. In this way he acted as a kind of bomb, demolishing the old structure that it might be rebuilt by William Harvey and his successors. He was, however, too much of a religious mystic, with his four "pillars" of medicine—philosophy, astronomy, alchemy and the virtue of the physician—to become the founder himself of a new order of medicine. He speculated as rashly as did Galen, far more so than the Hippocratics, whose works present a remarkable contrast in their scientific soberness to the fanciful dogmas of this physician born two thousand years later.

The book under review, the first modern translation into English of any works of Paracelsus, is a labour of love to mark the four-hundredth anniversary of his death. Like all such labours it has been carefully and well done by the four collaborators. From it the reader may gather both the merits and faults of "Lutherus medicorum", as Paracelsus was styled, his interest in drugs, occupational diseases and psychiatry, his self-assurance, conceit and tendency to wild speculation. The fourth treatise of the book is scarcely medical at all, but throws light on the mystic belief in sylphs, nymphs, pygmies and salamanders, the spirits living in the four so-called elements.

Paracelsus was no bigoted adherent of the doctrine *nihil in intellectu nisi prius in sensu*. He was convinced that there is a higher knowledge than that coming through the senses, a knowledge coming direct from God through the agency of the Holy Spirit. A similar belief has been held by many great minds with the religious instinct strongly developed. It inspired the work of Plato and St. Paul, while in a humbler sphere it has guided the lives of millions of simple folk, who have been as sure of its truth as of their own existence.

W. H. S. JONES.

THE INDIAN FARMER

Sons of the Soil

Studies of the Indian Cultivator. Edited by Dr. W. Burns. Pp. ix+128+44 plates. (Delhi: Manager of Publications, 1941.) 2.6 rupees; 4*s*.

INDIA and her politicians, not without good reason, have been much in the news during recent months, but, in the long view, it is her peoples, comprising a vast and varied agricultural population, who will dominate the historic scene. For this reason the attractive and well-illustrated little volume, edited by Dr. Burns, agricultural commissioner with the Government of India, should be carefully read at the present time. The Indian cultivator "is India outside of the towns". His agricultural difficulties are great and of long standing; they are as varied as the territory in which they arise. The object of the sketches in the volume under review is, among other things, to get rid of the idea of the Indian cultivator as a person or type, and to show something of the variety of individuals and classes who cultivate the soil of this immense country.

The several sketches or essays have been written by competent people possessing intimate knowledge of particular regions and their inhabitants, both British and Indian names appearing in the index of contributors. It is a rich and colourful assemblage, in which one notes many points of difference but, fundamentally, with a vein of similarity throughout. From the objectively written articles one forms an impression of an essential plainness of life wherever the cultivator is at work, a similar hard wrestling with the difficulties of soil infertility and the uncertainty of climate; but throughout there is a philosophy and attitude of mind which, financial indebtedness notwithstanding, enable those sons of the soil to live their lives cheerfully and in a spirit not lacking in neighbourly helpfulness.

A THEORY OF THE STRENGTH OF METALS*

By SIR LAWRENCE BRAGG
O.B.E., F.R.S.

THE shear stress at which a metal passes beyond the elastic range and begins to yield is ill-defined. It is very small for highly perfect single crystals, and less for an annealed polycrystalline specimen than for one which has been hardened by cold work. It has often been pointed out that there is no elastic limit in a typical plastic metal, since the apparent stress at which the metal begins to yield depends upon the sensitivity of the means for detecting very small rates of flow. Nevertheless, the elastic limit and ultimate strength of metals can be stated in round figures; were it not so, the engineer would have no basis for his calculations.

It is generally accepted that the effect of plastic deformation by cold-working is to break down each of the crystalline grains, which are seen in polished and etched specimens, into a mosaic of much smaller crystal fragments with different orientations. These fragments have been termed 'crystallites' by some X-ray workers, though this term was originally coined for crystal skeletons, and is so used by the metallurgist (cf. Desch, "Metallography", p. 137), or is used in some countries to denote the crystal grains themselves. They will be termed 'mosaic fragments' here, in order to avoid specifying too clearly their physical nature. Their size may be estimated by the broadening of X-ray diffraction lines which they produce. Progressive plastic deformation of an annealed metal at first breaks down the crystal grains into ever smaller fragments, but there appears to be a limit to the process. An excellent summary of the X-ray diffraction phenomena was given in a paper in 1938 by H. J. Gough and W. A. Wood in the *Journal of the Institution of Civil Engineers*. The changes in crystalline structure during the progressive cold-working of pure copper, silver, nickel, aluminium, molybdenum and iron have been studied in a series of very interesting papers by W. A. Wood[1], and he gives estimates for the lower limiting size of the 'crystallites' ranging from 10^{-4} cm. for aluminium to $0 \cdot 7 \times 10^{-5}$ cm. for copper. Some speculations about the nature of this fragmentation and the factors which govern this lower limiting size are put forward at the end of this paper.

It is not easy to separate the effects of strain, lattice curvature and crystal size upon the X-ray line broadening. However, a picture such as is represented in Fig. 1 will be assumed, where the heavy outlines are those of the original crystal grains revealed by etching, and the pattern inside the grain represents the mass of mosaic fragments or crystallites produced by the deformation, with orientations shown by the hatching, which may vary over a certain range (30° in the figure) or in an extreme case may be quite random.

Although the elastic limit of a metal is so ill-defined, this does not rule out the possibility of a strict relationship between this limit and the average size of the mosaic fragments. Variations in this limit from specimen to specimen of pure metal may be ascribed to differences in this size, and the increasing stress which the metal can withstand with increasing deformation may be ascribed to a corresponding decrease of average fragmentation size during the experiment. It is the purpose of this communication to establish such a relationship. The treatment bears some formal analogies to the well-known treatment of the mechanism of plastic deformation of crystals given by G. I. Taylor[2], but it is based on a somewhat different physical interpretation and it is hoped that it has certain novel and suggestive features.

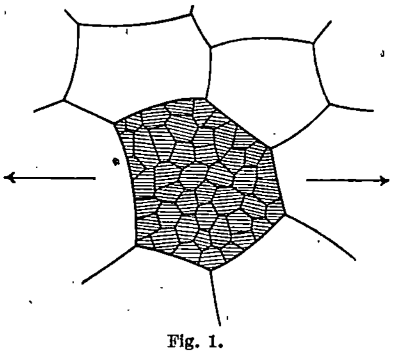
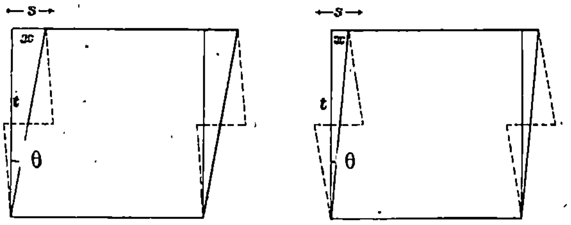


Fig. 1.

Relation between Elastic Limit and Average Mosaic Fragment Size

In the first place, if Wood's figures for the lower limit of fragment size be accepted, a very simple treatment shows that they lead to an estimate of ultimate strength which is of the same order as that which is observed. Fig. 2 represents a fragment, for simplicity supposed to be a small cube of volume V and side t, embedded in the metal matrix. Also for simplicity it is supposed that the general shear strain of the metal in which it is embedded is parallel to the glide planes of the fragment and is in the direction in which glide takes place. The displacement of the top of the fragment with reference to the bottom is given by $x = \theta t$, when θ is the shear angle. Let s be the interatomic distance, which is the unit of displacement of the glide process. It will be clear from Fig. 2 that the fragment, forced into this strain by the surrounding matrix, will not yield by gliding on any intermediate plane unless x is greater than $s/2$, because if x is less than $s/2$, the strain is greater after the glide than before it commenced. To put it formally, glide will only take place if it represents a release of energy, that is, if



$x > s/2$
Strain decreased by glide

$x < s/2$
Strain increased by glide

Fig. 2.

$$\tfrac{1}{2}n\left(\frac{x}{t}\right)^2 . V > \tfrac{1}{2}n\left(\frac{x-s}{t}\right)^2 V.$$

$$\text{or } x > s/2, \qquad (1)$$

n being the coefficient of rigidity.

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* Substance of a lecture delivered at the Royal Institution on March 31.

This estimate of the critical value for x is a minimum, because the direction of shear has been taken to coincide with that of glide. Actually, glide has to take place along the most favourably situated plane and direction, which are in general inclined to the shear. To calculate the order of the effect, it may be taken that glide will not occur in this particular fragment until the general shear strain reaches such a value that

$$x \sim s.$$

All the fragments are subject to this condition. The whole metal will therefore withstand a shearing stress

$$T \sim ns/t. \qquad (2)$$

To take the case of pure copper, for example, for which $n = 4{\cdot}5 \times 10^{11}$ dynes per cm.^{2}, $s = 2{\cdot}56$ A., and according to Wood[1] $t = 0{\cdot}7 \times 10^{-5}$ cm. :

$$\begin{aligned} ns/t = 4{\cdot}5\times10^{11}.\ 2{\cdot}56\times10^{-8}/0{\cdot}7\times10^{-5} & \\ &= 1{\cdot}64 \times 10^{9} \text{ dynes per cm.}^2 \\ &= 1{,}640 \text{ bars} \\ &= 10{\cdot}6 \text{ tons per square inch.} \end{aligned}$$

The figures for several pure metals for which Wood gives a lower limit of crystallite size are as follows :

	t(cm.) Wood	n(dynes/ cm.^{2})	s(A.)	ns/t (bars)	ns/t (tons/ in.^{2})	Observed elastic limit (tons/ in.^{2}) Wood	Observed ultimate strength (bars)
Copper	$0{\cdot}7\times10^{-5}$	$4{\cdot}5\times10^{11}$	2·56	1640	10·6	—	2200
Nickel	$1{\cdot}2\times10^{-5}$	$7{\cdot}7\times10^{11}$	2·49	1600	10·3	—	5000
Silver	$0{\cdot}8\times10^{-5}$	$2{\cdot}9\times10^{11}$	2·88	1050	6·7	—	1300
Iron	$3{\cdot}2\times10^{-5}$	$8{\cdot}3\times10^{11}$	2·42	630	4·1	3·75	2500
Aluminium	$10{\cdot}0\times10^{-5}$	$2{\cdot}6\times10^{11}$	2·86	74	0·48	0·50	600

The figures in the last column represent ultimate strength as given in Landolt and Bornstein (maximum load before necking sets in) / (initial cross-sectional area). They cannot be directly compared ; they merely show that the calculated figures are of the right order. To obtain a satisfactory check, the crystallite size must be measured on the material which is just withstanding the stress. For example, Wood and Smith[3] give a stress-strain curve for pure aluminium, which shows an elastic limit for tension of 1 ton per square inch corresponding to a limiting shear stress of 0·5 ton per square inch, which agrees with the value 0·48 ton per square inch calculated on the basis of Wood's estimate of crystallite size in aluminium. Their corresponding figure for pure iron[4] is 7·5/2 = 3·75 tons per square inch, which also agrees with the figure 4·1 tons per square inch in the above table. Only the order of the agreement is significant.

The above simple picture of the condition which determines slipping must be modified because no account has been taken of the additional strain in the neighbouring crystallites produced by the dislocations at either end of the glide plane. Although no attempt is made here to calculate this effect quantitatively, the type of modification it will introduce can be seen as follows. Let it be supposed that the dislocation, of amount s, produces an additional strain sf at a point P in its neighbourhood when f is some function of the co-ordinates of P. The additional energy along the two dislocation lines each of length t is

$$\tfrac{1}{2}n\int\left\{(\theta + sf)^2 - \theta^2\right\}2t\,dA,$$

where dA is an area element. The total additional energy is therefore, by integration

$$\tfrac{1}{2}\,nt\,(2s\,\theta\alpha_1 + s^2\alpha_2),$$

where $\alpha_1 = 2\int f dA$, $\alpha_2 = 2\int f^2 dA$ are constants depending only on the function f. Hence the condition for slip becomes, putting $V = t^3$, $\theta = x/t$,

$$\tfrac{1}{2}\,n\left(\frac{x}{t}\right)^2 t^3 > \tfrac{1}{2}\,n\left(\frac{x-s}{t}\right)^2 t^3 + \tfrac{1}{2}\,nt\left(\frac{2x}{t}.s\alpha_1 + s^2\alpha_2\right)$$

$$\text{or } x(1 - \alpha_1/t) > s(1 + \alpha_2)/2.$$

If t becomes so small that α_1/t approaches unity, the strain cannot be released by slip ; in other words, the material behaves in a brittle manner. If it is well within the plastic range, it may be assumed that $\alpha_1/t \ll 1$. This would not be true if one assumes Timpe's formula (G. I. Taylor, p. 376, *loc. cit.*), where f is of the order $1/r$, but there is probably some local atomic adjustment in all dimensions which eases the strain at the ends of the glide plane. No estimate of α_2, which measures the energy of a dislocation apart from any pre-existing strain, is made, but if it is small it follows that

$$\text{Limiting stress } T = \alpha\, ns/(t-t_0), \qquad (3)$$

where the constant α is certainly greater than 1/2 and is probably about unity, and $t_0 (= \alpha_1)$ is a lower limit of fragment size below which the metal becomes brittle.

A formula of the same general type as (2) is given by G. I. Taylor (*loc. cit.*, p. 379) for the condition that two 'dislocations' should be able to pass one another. The critical shearing force to affect this is given by

$$S = \frac{\mu\lambda}{2\pi h},$$

where μ is the coefficient of rigidity, λ the interatomic distance, h the nearest distance of the slip planes on which the dislocations are situated. I prefer the present way of regarding the problem, because it makes no postulates about the arrangement of the dislocations, but is based on the average fragment size for which there is direct X-ray evidence.

One point may be noted briefly. The yield of one fragment imposes an extra strain on its neighbours, as has been seen above. If they are already strained nearly to the limit, they will yield in their turn. Thus an avalanche of yielding will run right across an individual crystal grain along the mean direction of the glide planes as shown by the arrows in Fig. 1. It may be many fragments in breadth and so of macroscopic size. The explanation of the slipband in some such way has often been proposed, but the above picture perhaps explains it rather more realistically.

To sum up, the point of view adopted here is that it is possible to calculate the limiting stress a metal will stand elastically without making any assumptions about the way glide is initiated or travels in a single crystal, or about the forces required to produce it, beyond assuming they are very small, which is known to be the case. If a mosaic fragment is strained beyond the point at which a glide of one interatomic distance will reduce the strain energy, it is unstable and the glide is certain to take place. This condition by itself suffices to determine the elastic limit. Much emphasis has been laid in the past on the necessity of studying the gliding process and strength of a single crystal before the polycrystalline metal can be understood. It would appear that, paradoxically, the reverse is the case. The strain hardening of a single crystal is a complex process depending on the progressive deterioration of its perfection, whereas the cold-worked metal has attained a constant statistical average as regards the size of its mosaic fragments, and thus attains the constant strength calculated here.

Physical Nature of the 'Mosaic Fragments' or 'Crystallites'

The cold-worked crystal grain is pictured above as a mosaic of fragments meeting at well-defined interfaces, each having a perfect crystalline pattern throughout its own domain. It is not intended to convey the idea that this is necessarily the true picture. It has certain attractive features which I outlined in a note on "The Structure of a Cold-worked Metal"[5]. The structure was there described as resembling a foam, with movable boundaries able to take up positions of equilibrium. It was shown that such a structure, if momentarily broken down into a very fine scale, would rapidly recrystallize at first up to a certain characteristic size, whereupon the process would become so slow as practically to cease. Some such effect must exist, in order to account for the constant mechanical strength of the cold-worked metal which is characteristic of it and persists, but other models may give an equally good explanation. What is observed is a broadening of the X-ray line, which may be caused by small crystal size, or by some distortion of the lattice with its consequent strains. The formula (3) for the stress which the metal will withstand is independent of the precise picture of the nature of the fragmentation. Let us suppose, for example, that the cold work produces, not a mass of perfect fragments differing in orientation, but a crimping or waving of the lattice planes so that successive small regions make an angle with each other, but all crystalline coherence of one with the next is not destroyed. The constant t, interpreted above as the dimensions of a fragment, would then become the repetition interval of the crimping. Such a modulation of the perfect crystal spreads the sharp X-ray reflexion into side-bands. By optical principles, the spread of these side-bands due to this modulation at intervals of t is the same as the broadening of an X-ray line produced by independent perfect crystals of width t, although there are certain rather subtle differences in the X-ray diffraction effects which may throw light on the true nature of the fragmentation. The point to be emphasized, however, is that if we suppose the crimping to limit the elementary gliding process to regions of dimensions t, the same dimension t will also determine the broadening of the X-ray lines, and the formula (3) above will hold.

In conclusion, I wish to express my warm thanks to Dr. E. Orowan for helpful discussion and criticism. Dr. Orowan's note on slip-bands in NATURE of April 12, 1941, p. 452, suggested the fundamental idea on which the above explanation of the strength of metals is based.

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[1] Wood, W. A., *Proc. Roy. Soc.*, A, **172**, 231 (1939).

[2] Taylor, G. I., *Proc. Roy. Soc.*, A, **145**, 362 (1934).

[3] Wood, W. A., and Smith, S. L., *J. Inst. Met.*, **67**, 315 (1941).

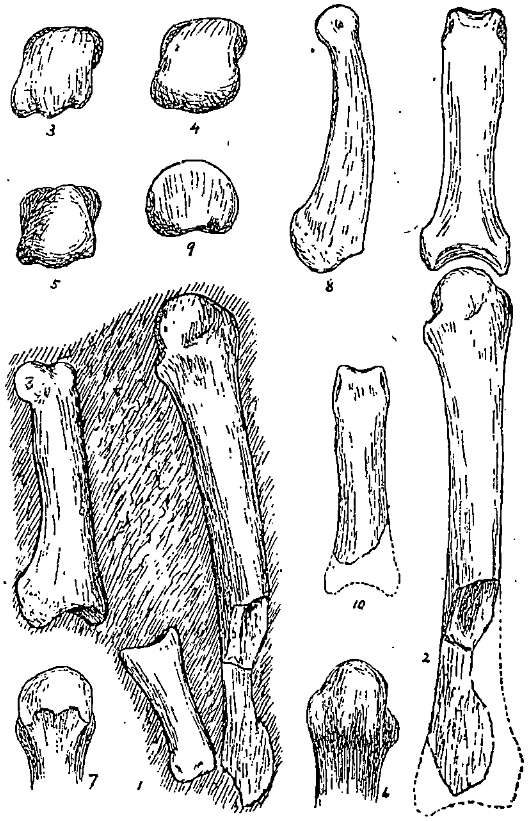
[4] Smith, S. L., and Wood, W. A., *Proc. Roy. Soc.*, A, **178**, 93 (1941).

[5] Bragg, W. L., *Proc. Phys. Soc.*, **52**, 105 (1940).

THE HAND OF THE APE-MAN, *PARANTHROPUS ROBUSTUS*

By DR. R. BROOM, F.R.S.
Transvaal Museum, Pretoria

THE block of bone breccia in which the beautiful skull of Paranthropus was found has already yielded us the distal end of a humerus, the proximal end of an ulna and two toe bones. The matrix on which the maxilla rested has remained until recently untouched, as it retains the excellent impressions of the premolars and the first and second molars. In this matrix there was exposed a little piece of bone which I thought might prove interesting. On following it in, I found it was part of the well-preserved second metacarpal of the left hand. Close to it I also found two phalangeal bones, and in another piece of matrix much of another phalangeal bone. The distal end of the metacarpal lay within a millimetre of the maxilla.



FINGERS OF PARANTHROPUS. NATURAL SIZE.

1. Bones in relative position as found.
2. 2nd left metacarpal and proximal phalanx of Paranthropus.
3. Distal end of 2nd left metacarpal of Paranthropus.
4. Distal end of 2nd left metacarpal of Bushman.
5. Distal end of 2nd left metacarpal of baboon.
6. Palmar side of distal end of 2nd metacarpal of Paranthropus.
7. Palmar side of distal end of 2nd metacarpal of baboon.
8. Side view of proximal phalanx of 2nd left finger of Paranthropus.
9. Proximal end of proximal phalanx of 2nd left finger of Paranthropus.
10. Probably proximal phalanx of 4th finger of Paranthropus.

The metacarpal bone is perfect, except for the loss of the proximal end. It is long and slender, and not like the metacarpals of any of the living anthropoids.

It is more like the metacarpal of the Bushman, but longer and more slender. It is quite certainly not a human metacarpal. In a number of respects it resembles the baboon metacarpal, but it is about a quarter larger than the corresponding metacarpal in a large male *Papio comatus*. The distal end of the metacarpal is essentially cercopithecid in character, and there can be little doubt that there must have been as in the baboon a pair of sesamoids.

We know that in man a pair of sesamoids is present at the distal end of the first metacarpal, and one is frequently present at the distal ends of the second and fifth metacarpals. But radiologists have recently found that other sesamoids are also not infrequently present. There may be one or a pair of sesamoids present at the distal ends of all the metacarpals. It thus seems probable that the ancestor of man had a pair of sesamoids at the distal ends of all the metacarpals, as in the baboons.

The large phalangeal bone is almost certainly the proximal phalanx of the same finger as the metacarpal. It is almost typically cercopithecid in structure, but deeper proximally than in the baboon.

There will doubtless be those who will argue that these skeletal remains do not belong to the skull. I understand that opinions have been expressed that the humerus may be that of a chimpanzee, or even that it is human; and possibly it will be held by some that the hand bones I have discovered are those of a giant baboon. All these skeletal remains were found in the same piece of bone breccia, which is less than a cubic foot in size and which gave us the Paranthropus skull; and as the metacarpal is certainly that of a large Primate, it seems to me probable that the hand, the skull, the humerus, the ulna and the toe bones are all the bones of the skeleton of one individual. If this is so, we get a few interesting facts about the structure of this remarkable ape-man.

A giant Pleistocene baboon, *Dinopithecus ingens*, has, however, been found in the Transvaal, but it is not known to occur at Kromdraai; the only large baboon at Kromdraai being *Parapapio major*, which is not larger than the living baboon. If ever teeth of Dinopithecus are discovered at Kromdraai, the question will of course arise as to whether these hand bones, though closely associated with the Paranthropus skull, are not really bones of the hand of Dinopithecus.

At Sterkfontein there has been discovered a large baboon-like pelvis, with a femur and three vertebræ. These may be parts of the skeleton of Dinopithecus. The femur is considerably smaller than the supposed Plesianthropus femur, and more baboon-like. It is thus possible that Dinopithecus may have been contemporary with Paranthropus, and it may be argued that the finger bones are those of Dinopithecus.

It may be many years before we get a hand of Dinopithecus in association with a skull or teeth, and even if we do I do not see how we shall be able to prove that it is not a hand of Paranthropus in association with a Dinopithecus skull or teeth, unless we also get an associated humerus.

From the shape of the distal end the metacarpal is manifestly a metacarpal of the left hand, and the only point that might be debated is whether it is a 2nd or a 5th metacarpal. The shape of the distal end seems to leave no doubt that we are dealing with a 2nd metacarpal; and if it is a 2nd metacarpal the posterior part of the bone is quite differently shaped from that in the baboon. If we are dealing with a 5th metacarpal, whereas the shaft is like that of the baboon, the distal end is very different. If we compare the bone with that of the Bushman, we find a considerable agreement except that the bone is longer and more slender, and the distal end has clear evidences of there having been two sesamoids in association. All the available evidence points to a closer affinity with the Bushman metacarpal than with that of the baboon, except that as there have been two well-developed sesamoids the distal end resembles considerably that of the baboon. The sesamoids have also led to the proximal end of the phalanx being more baboon-like than man-like.

The little phalangeal bone found beside the metacarpal is manifestly a first phalanx. It cannot be a thumb-phalanx. It might perhaps be the first phalanx of the 5th finger of Paranthropus. If so, the 5th digit would be remarkably small and short. There is, however, another possibility, and even a probability. In the same block of matrix is a fragment of the frontal bone of a small 'baboon'—probably *Parapapio angusticeps*—a small 'baboon' which is fairly common at Kromdraai; and it seems that the most natural determination of this small phalangeal bone is that it is a phalanx of *Parapapio angusticeps*.

This hand is closely associated with the skull of Paranthropus, and it seems to me so much more probable that the hand belongs to the same individual as the skull that I believe that this is the hand of Paranthropus, even though it has some cercopithecid characters. In any event it seems but right to figure the specimens and place the facts before the world that others can consider the matter.

We know that the milk teeth of Paranthropus and Australopithecus have retained many cercopithecid characters lost in the living anthropoids, and we need not be surprised to find cercopithecid characters in the metacarpal and phalangeal bones.

If the hand is that of Paranthropus, then we have a type that has no close resemblance to that of the living anthropoids, but a type somewhat intermediate between that of the baboon and man. This does not mean that Paranthropus is descended from a baboon, but only that the ancestor had retained some cercopithecid characters.

Until recently I inclined to follow Gregory in believing that man has been derived from a primitive Dryopithecid; but as the living anthropoids and most of the fossil Pliocene forms have teeth characters not found in man and the Australopithecines, I now think it more likely that man and the Australopithecines came from a pre-Dryopithecid, a view which is favoured by Weidenreich, and a little like the views of Osborn and Wood-Jones. If the hand is that of Paranthropus, we have additional evidence in favour of this view.

If we compare these hand bones with the large bones of the gorilla, chimpanzee and the orang, we might readily conclude that they are too small for the hand of an animal about as large as a large chimpanzee. But we know that Plesianthropus, which is allied to Paranthropus, had an os magnum even smaller than that of the Bushman, and had thus almost certainly a small, rather delicate, hand. We know that the supposed Plesianthropus os magnum cannot possibly be the os magnum of a baboon; and we are thus apparently justified in holding that the large finger bones very closely associated with the Paranthropus skull really belong to Paranthropus.

SCIENCE AND SOCIETY

By DR. F. SHERWOOD TAYLOR
Museum of the History of Science, Oxford

AT the twenty-first annual general meeting of the University Catholic Federation of Great Britain, which took place at Birmingham during April 10–12, three conferences were held on the theme of "Science and Society". The first conference was concerned with the question, "What is Science ?", and under the chairmanship of Prof. Thomas Bodkin, professor of fine arts in the University of Birmingham, was opened by a paper from Dr. F. Sherwood Taylor, curator of the Museum of the History of Science of the University of Oxford, entitled "An Historical Survey of the Rise of Science".

Dr. Sherwood Taylor pointed out that the rise of science was contemporary with that of civilization. Its first stage was the rational treatment of crafts and the study of phenomena which had religious significance. The Egyptians and Chaldeans were the chief originators of science in its practical aspect, but theoretical science, the philosophy of Nature and natural causes, had to await the genius of Greece, which excelled in the abstraction of general principles, yet was defective in its rash assumption of a universal correspondence between that which the mind conceived as fitting and that which in fact existed. The Greeks, and the immediate heirs of their achievement, excelled in all which could be investigated geometrically, but were comparatively deficient in those sciences which could be acquired only through the discipline of the laboratory, which began to have importance only when the wave of ancient science was fast receding. In the period A.D. 300–1100 Europe was barren of scientific achievement, because wholly preoccupied with political reconstruction, and with the enormous implications of the central fact of human history, the Incarnation. The attitude of this period towards natural science was that speculation with regard to it in no way furthered a blessed life, and so was a culpable waste of time and talents. Meanwhile, the philosophy of Greece blossomed again in Islam, and when it came to Western Europe and was assimilated with Catholic doctrine, Greek science came with it. In the thirteenth century such men as Albertus Magnus, Roger Bacon, Peter Peregrine, Mondino, and the numerous alchemists gave good hope of an age of experimental science. But it was not to be, and the wave of modern science which is yet gathering force took rise from a different source, the Platonic speculations of such men as Marsilio Ficino.

After a century or more, when science was regarded, with natural magic, as an arcanum, the genius of Galileo demonstrated the practice of modern science, while Francis Bacon enunciated its theory. Here came perhaps the most portentous step in world history, the separation of natural knowledge from philosophy and religion. Natural knowledge, by limiting its objective, became cumulative, and ever more swiftly grew to its present bulk. The economic application of science, previously unimportant, became finally predominant. Industrial civilization led to the horrors of exploitation in the nineteenth century, and each succeeding half-century has brought to mankind a more numerous crop of revolutionary inventions. The next half-century is likely to transform the world even more profoundly than the last, for good and evil: Are we to let it proceed without rational direction or control ?

The second paper in this conference was given by the Rev. J. Leycester King, S.J., professor of psychology at Heythrop College, who took for his subject "Science and Reason". He emphasized that a large part of the world's troubles can be traced to a desertion of scientific ideals, the substitution of illusion for fact. Science is alive to the discord and irrationality of the modern world, and to the implications of the policy of tampering with truth, which policy is the antithesis of science. Yet most of those who seek a remedy in science are themselves, consciously or unconsciously, subject to the illusion, long discarded by philosophy, that only what is mediately or immediately observable is real. Science must realize that there are unobservables which are real, and which are within the competence of human thought to study and systematize. These matters are now reserved to philosophy and theology. Science, divorced from these, has made rapid progress, it is true, but this progress has only been possible because science and its workers are embedded in a civilization based upon Christian principles. The knocking away of the Christian foundations of our civilization has already resulted in self-deception, illusion, wishful thinking and unreason, and though we may point in priggish horror at the deliberate distortion of truth practised by our enemies, we are not to forget that we are ourselves already far down the slope of disintegration.

We have been living on our spiritual capital. Our need is not of more science, or of less science, but of formulating an end and meaning of life, perceiving a unity in which the harmony of the manifold appears. Our knowledge of this unity will but increase the purity and vigour of science, for the truth inherent in the whole must subsist in the sub-wholes which form our field of investigation. Science must be re-married to philosophy, which alone can provide a datum-line of immutable principles, about which oscillate the dogmas of science, of which so many have been proclaimed as infallible, then modified, and at last abandoned. Separated, philosophy and science must fade and pine: united they have the grandest of futures.

The second conference, under the chairmanship of Dr. Hugh O'Neill, chief metallurgist of the London, Midland and Scottish Railway, was concerned with the social impacts of science, and was opened by Prof. Louis Renouf, professor of biology at University College, Cork, with a paper entitled "The Influence of Modern Biology". Modern biology, he indicated, begins with Darwin, and since its inception has exerted the most conspicuous influence on human thought. Darwin's notion of organic evolution was intended to be, and in fact proved, a most valuable working hypothesis for science, but in the able hands of T. H. Huxley, and later as "travestied by Haeckel", it became the foundation of the materialistic biology which has vastly influenced the popular beliefs of the modern world. Biology and physiology have entered the field of human behaviour; the attempts made to account for moral codes in terms of endocrine glands are good examples of their more extreme methods. To-day social biologists have enormous prestige and popularity, and problems of human society have come to be thought of in biological terms. It is of the greatest importance, then, that the biologist should be fitted for his present responsibilities. But, in fact, the greatest part are reared in a materialistic atmosphere, and acquire a philosophy which is manifest in the first-class research work which is to-day being presented in an irrelevant matrix of Marxian philosophy. Catholics, and indeed Christians in general, are at fault in looking upon all forms of science with a timidity that is a relic of a past defensive attitude. There is a great need for more Christian men of science, especially biologists, who may oppose a truly personalist attitude to the decadent views falsely put forward as the answers of science to the human problems of marriage, education and family relationships. One of the most important steps to be taken is the proper education of medical men. The medical course is long, and commonly admits of few but professional studies, whereas it is most desirable that medical men should have some knowledge of sociology, the arts and the elements of philosophy. A preliminary year's course of humanistic studies would be of great value to men who will have so important a position in the social structure.

There followed a paper on "Science and Man" by Dr. H. P. Newsholme, professor of hygiene in the University of Birmingham. The most important effect of science on the community was its example of single-minded search for truth, and discarding of emotional and personal feelings; but this setting aside of all but the material aspect of things, though it arise from a recognition of the incapacity of science, may lead to the implicit assumption that the material aspect alone is worthy of consideration. This limitation of outlook has led to correspondingly defective results. Thus Freud did good service in opening up the subconscious, but failed to recognize in it an avenue of God's approach to man. In the region of the physical life and of social environment the debt of humanity to science has been incalculable. But though the health and comfort of man has been increased, the troubles of his spirit are left untreated.

The great prestige of science has led society to respect the opinions of its workers, and their implicit materialism has contributed to the formation of a materialistic society, which in turn rears more materialistic scientific workers. Not only science, but also almost every human activity, has become dissociated from religion, and the immediate consequence has been their exploitation by the selfish. Scientific agriculture has led to denudation and sterility; family limitation is depleting the population and degrading it by separating the pleasures of sex from its responsibilities. Furthermore, the exaltation of the physically fit as alone worthy of survival threatens the world with the arrangement of mating on physical grounds, with sterilization of the so-called unfit, and with euthanasia, which leads by a short step to the deliberate 'elimination' of the aged, mentally deficient or incurable. In the realm of ideas the effect has been even to extend natural law beyond its function, which is the summation of past events. Such events as find no place in the records of science, for example, miracles, such as the Resurrection, the greatest of them, are sometimes denied; and theories, such as that of organic evolution, are extended from body to mind. If science had retained its association with religion, it might have grown more slowly, but the product would have been richer and more significant, and the world would have been protected against the worst types of exploitation of the powers of science.

The final conference was presided over by the Right Rev. Bernard Griffin, Bishop Auxiliary of Birmingham. The Rev. Philip de Ternant contributed a paper on "The Place of Science in Education". His title, he said, was not science in the school, which is another subject. At the time of Alcuin the concept of a scholar was primitive but comprehensive. The old Trivium and Quadrivium contained the germ of scholasticism and of *universities*: it involved recognition of the *unity* of the *universe* and of the spirit of man. One idea may be seen to underlie these three forms of a single word. As material knowledge increased, specialization became necessary, but to-day's is much overdone in response to the utilitarian age. Our task is to create a reversion to the older type of scholar and to re-integrate the scattered elements of knowledge, now known only collectively as science. The great specialists are noteworthy for the breadth of their basic knowledge, but men of science generally lack philosophy to-day. The true purpose of a university has been disnatured by fetishes, popular and scholastic. The width of outlook and general interest formerly displayed in the older "Academes", from the Royal Society down to local field clubs, and in the followers of nature hobbies in the family circle itself, is much needed to-day.

The Rev. Philip de Ternant advocated the 'perennial' philosophy of St. Thomas Aquinas and his modern followers, such as Maritain, in opposition to the widespread aberrations of to-day, and asked for a primer or handbook on the subject adapted to the use of science students. He regretted the obscurantism of the public and of certain pious people. St. Thomas had established that the study of natural science is a religious duty, as leading us, first to consideration and admiration of the Divine Wisdom, thence to reverence, fear and especially love, when the goodness and beauty of created things attracts the souls of men and leads to a comparison of the same things in a higher form in God; finally it sets up in men a certain similitude of the Divine perfection and wisdom. So, also, a wrong notion of the nature of creatures leads us to think they are all that exists, and that men are subject to laws which do not exist. So, argues St. Thomas, that opinion is false which says that it matters nothing to religious faith what anyone thinks of creatures, so long as he is right with God; for error concerning creatures leads to a false idea of God, and so leads minds away from Him. Therefore scripture threatens with penalties, as if they were pagans, those who have a false idea of natural facts: "Because they have not understood the works of the Lord, and the operations of his hands: thou shalt destroy them and shalt not build them up" (Ps. xxvii, 5).

QUANTITATIVE AND QUALITATIVE METHOD IN SOCIOLOGICAL RESEARCH

THE principal item on the Saturday (April 11) meeting of the British Psychological Society at Brighton was the open discussion in the evening between Mr. Henry Durant of the British Institute of Public Opinion, and Mr. Tom Harrisson of Mass-Observation. Mr. Durant opened the discussion by supporting the proposition "that Empirical Methods in the Social Sciences should be Predominantly Quantitative".

Social scientists should, in their empirical work endeavour to employ methods and concepts producing quantitative results. In Mr. Durant's view, organized science in the physical world is based upon measurement. These measurements can be tested and verified because they are based upon units of measurement which are objective and can be handled by any investigator. By insisting upon the quantitative method and developing its use in every direction possible, more and more phenomena are being reduced to quantitative terms. Biology took an immense step forward when genetics with its statistical basis was developed. Sound has been provided with its unit of measurement and is but the last in a list of qualities which can now be handled quantitatively. It is true that some physical sciences, for example, physiology, are not, at the present time, predominantly statistical in character. It is also true that the work of the biochemist and the crystallographer is rapidly providing a quantitative, mathematical basis for sciences such as physiology.

In the social sciences, Mr. Durant said, it is possible to point to quantitative elements in a discipline so 'qualitative' as psycho-analysis. Freud develops the concept of displaceable energy which can attach itself to either the ego or the id. If there is reality in this concept, units of measurement will inevitably be developed, and actually work along these lines is being done at the present time. Prof. J. D. Bernal, in a recent paper read before the British Association, discussed the importance of obtaining statistical data by means of social surveys. "It is true that we have not got accuracy to seven figures, but without a snap survey action has to be taken with no figures at all, and even one figure arrived at roughly marks an enormous improvement, mathematically an infinite gain."

Mr. Durant thinks no one should hope that social science can be reduced solely to statistical data. In every investigation the man of science, whether or not he is aware of it, is employing a social theory. The problems he investigates, the concepts he adopts, are in all cases part of a much larger whole which, when consistently extended, temper of the physical scientist. He must try to test his hypotheses by observation, since experiment is largely denied to him. It is no argument that the social sciences are still young and must, therefore, be content with the qualitative methods which formerly characterized all sciences. The history of science indicates that progress is most rapid when there is the most vigorous insistence upon exact statistical measurement. Often the unit of measurement is difficult to develop and the technique of measurement presents even greater problems. It is the task of the social scientist to overcome these difficulties in his own field, for only by these means will he be able to eliminate the subjective bias which characterizes so much work which is being done at the present time in the social sciences.

Mr. Tom Harrisson, opposing Mr. Durant's arguments, stressed first of all the scope of disagreement and discussion. He agreed, of course, that quantitative methods are essential in all empirical studies. The difference of opinion here was not on the method but the emphasis; he rejected the conception that such research *must* be predominantly quantitative. It should be secondarily quantitative. Parallels with the physical sciences can be misleading, because they have already a living tradition of procedure, accepted research standards, a great body of proved and agreed basic theory and theses. The social sciences, unfortunately, developed much later, and there is still no common outlook or interchange within the whole field of social research. Empirical work has been scrappy and diffuse; much of it has been quantitative and the proportion has increased very much lately. The War has given a big fillip to the social sciences, for in the present periods of vast social and psychological change, new problems present themselves to Government departments and others, which urgently require attention from the psychologist, the sociologist and the student of public opinion.

Social science has not been well enough based and organized to respond to this call equally at all levels. It has tended to answer largely with quantitative studies, often without adequate appreciation of the background facts; there has been a tendency to assume that because some human factor can apparently be measured in percentage terms, the study is, therefore, necessarily 'scientific'. The useful device known as the 'random sample' has provided an easy method for studying what people *say*. A few thousand interviews give a picture which will not be appreciably altered by interviewing the whole population. This quantitative method has, therefore, attracted much of recent social science. But because results are statistically consistent, it does not follow that they do not give a 'false' picture. By themselves they may be misleading, especially because we are still completely ignorant of the relationship between what people say to a stranger (the interviewer) and what they say to a friend; or between what people say, think and do. We are not yet in a position to know what weight can be attached to verbal behaviour; and at present we use interviews indiscriminately at our peril.

Mr. Harrisson feels that increased emphasis on this crude quantitative approach through the interview, without corresponding developments along other lines, such as observational technique, individual analysis, and penetration study of institutions, is unsatisfactory. In our present state of limited knowledge in social science, particular importance is attached to the full qualitative understanding of human phenomena, and at this stage the main function of quantitative methods, important as they are, is to act as a check, corrective and extension of the qualitative approach.

The social sciences have been slow to develop in Britain largely because the most educated and intelligent sections of the community are removed from the life of the mass of people who left school at or before the age of fourteen. It is difficult for the university professor to get down into the homes and hearts and minds of these people; few have done it objectively and over any length of time. Sociologists have long been conscious of this dilemma, and the sample method offered a way out—you ask people about themselves on a set questionnaire, or you pay others to go and ask for you, then tabulate the results in statistical detail. These results are important, in Mr. Harrisson's view, and there is room for many more of these studies, especially on the lines of the careful work done by the Wartime Social Survey; but to suppose that social science is thereby scientific, and that it can in fact progress far along primarily quantitative lines before the fundamental premises of method are proved (for example, the validity of social class, the distribution of temperamental types, geographical factors in outlook) is an abuse of the word 'science'. This word is too loosely used in the social sciences, where many of those concerned have not been trained in scientific method but on philosophical lines, so that they too easily accept decimal points as objective data.

Mr. Harrisson urged that we need less partisanship in social science, which is still embryonic. Every method, every study at this stage should be encouraged. But the primary and vital acts of empirical social study must always be qualitative. Mr. Harrisson welcomes the increase in quantitative methods, but deplores the growth of the idea that *only* such methods are socially scientific, an idea which is reflected in the wording of Mr. Durant's submission on this occasion.

In the discussion that followed, a wide divergence of view was expressed.

Dr. Gertrude Wagner spoke of the combined qualitative and quantitative method, and the need for social scientists to observe their own problems, to think them out qualitatively, then confirm their hypotheses by means of the quantitative method. She expressed the view that the only difference between Mr. Durant and Mr. Harrisson was as to whether there should be two hundred or two thousand interviews. Mr. Harrisson did not agree with Dr. Wagner on this, stating that there are sides of social science where no interviews are required, and current engrossment in the interview method was one of the things he was criticizing.

Dr. L. P. Richardson pointed out that the qualitative process is an essential initial step even in elaborate quantitative studies, as in the minutely accurate measurement work he had done in earlier days at the National Physical Laboratory. In comparing the weight of two bars of metal with the exactness required, it is still necessary to select the right bars for comparison by a qualitative act.

Dr. P. Senft discussed, in some detail, the philosophical relationship between quantitative and qualitative methods. Novelists like Proust and Stendhal have generally shown a far greater insight into human nature than psychologists and others approaching the same phenomena by quantitative methods.

Dr. Millais Culpin outlined some of his experiences during the work of the Industrial Health Research Board; he found the debate very like those he had heard long ago in medicine. It all boiled down to the old argument between those who were content to ask: What? and those who were also concerned to know: Why? The quantitative method is likely, if handled thoughtlessly, to lead into an interminable pursuit of the What, though the social sciences must be concerned very much with the Why.

Prof. M. Ginsberg expressed himself in favour of Mr. Harrisson's views. The idea that social research methods could be predominatingly quantitative, and that qualitative methods must merge into quantitative, is absurd. The suggestion that there is no real distinction between the two approaches is unsound. Quality does not pass imperceptibly into quantity. The two are distinct, and there are, in addition, many sorts of quality. The quantitative and qualitative approaches in themselves involve different concepts.

Dr. G. H. Miles's experiences in the field of market research have disillusioned him about crude quantitative methods in social study. He has seen elaborate statistical investigations which were built up on unsound methodological assumptions, such as a survey in which people were interviewed on certain food habits. They claimed to eat more butter than they could conceivably have consumed. For people often do not know what they really do, and more often give answers which show them as respectable citizens; people always want 'to show up well' in the interview.

Mr. Harrisson said that the discussion had cleared the air in a useful way. So long as social scientists were ready to interchange views and argue things out in a friendly atmosphere, so long would this be a vital and growing subject. There has been too much sociological over-sensitiveness to criticism in the past. Elasticity of outlook is necessary for the advance of any science; the development of science is largely the process of correcting somebody else's error.

Mr. Durant expressed the view that there had been a substantial body of agreement, and for his part he could not see any real difference of opinion, for he felt that in the end everything became quantitative.

PRODUCTION OF OPTICAL GLASS IN AUSTRALIA

By PROF. E. J. HARTUNG
University of Melbourne

THE manufacture of optical instruments of many kinds for the Armed Forces has become an important section of the extensive programme of munitions production undertaken by Australia in the present emergency. Of necessity, a new and complex industry of this type had to cope with many initial problems, among which the supply of suitable optical glass soon began to cause anxiety. Some glass was obtained from Great Britain and the United States, but in the dark months following the capitulation of France optical glass of good quality and in sufficient quantity was not obtainable. In certain directions, the need became so great that spectacle lenses were used, and blocks of glass for the prisms of tank periscopes had to be made by welding together many sheets of plate glass.

The decision to undertake the production of optical glass in Australia was made in the latter half of 1940, and subsequent events have shown most thoroughly the wisdom of this policy. About fourteen months after the first experimental work was initiated, full-scale production of glass of admirable quality commenced and has continued uninterruptedly, so that Australia is now not only completely independent of external supplies but is even exporting optical glass to other countries. This achievement has been due to close co-operation between the Chemistry Department of the University of Melbourne and the technical staff and facilities of Messrs. Australian Consolidated Industries Ltd., to which organization the actual production of the glass was entrusted. It is also a pleasure to record the very willing assistance received from the staff of the National Bureau of Standards, Washington, who placed freely at our disposal their extensive knowledge of technical details, thereby saving us much valuable time.

The original programme called for the production of six standard types of optical glass; this number was afterwards reduced to four which are now in production, but all six were made successfully in the laboratory. There were two main problems: (a) suitable raw materials for the glasses; and (b) suitable fire-clays for the pots. Fortunately, excellent sand was available in quantity, being in regular use for making flint glass for table ware. This sand contains less than 0·01 per cent iron oxides and the optical glasses made from it have proved to be almost ideal in regard to freedom from colour and turbidity. Other raw materials of high purity were soon located and removed further anxiety in this respect. The main experimental investigation was therefore directed to the selection of suitable pot-clays. About eighty specimens from various parts of Australia were examined as to refractoriness under load, shrinkage, chemical composition, especially iron and titanium content, texture and workability. From these about ten clays were selected for further trial; these were suitably blended and fashioned into small open pots holding about 2 lb. of glass each. These pots were fired in a small gas furnace and the glass batch introduced through a silica tube into the pot at 1,400° C. until the glass was in quiet fusion. After stirring with a silica rod, the pot was heated at a steady temperature (usually 1,450° C.) for 12 hours, cooled down, cracked open and the glass examined for pot contamination.

In such small pots, it was, of course, impossible to make optically homogeneous glass, but the resistance of the clays to glass attack and their general quality under the severe test conditions could be readily ascertained. It was felt that the results of these tests could be applied to the construction of suitable large pots with safety, owing to the better volume-surface ratio in the latter and the lower and more controllable temperature to which they would be exposed. These expectations were realized, and it was also found possible to slip-cast the large pots and dry them ready for the pot arch in about six weeks. As these pots can be raised to the temperature of the melting furnace in 4½ days, a great saving in time is thereby accomplished.

The pot-making and optical glass annexes have been very simply constructed to facilitate handling and reduce labour to a minimum. The capacity of the former is amply sufficient to maintain a supply of pots for a one-day melting schedule for the glass, which in turn reduces shift problems and operating costs, while the pot-handling and the stirring equipment is simple and efficient. After inspection of the chunks of glass from the pot, they are softened and moulded into the required blanks in special steel moulds which produce a very clean product, thus requiring only small tolerances. These blanks are then annealed in electric annealers before being finally inspected.

A most satisfactory feature of the production has been the high yield per pot (55–60 per cent) of usable glass, most of it of very high quality. For example, measurements by the National Standards Laboratory of Australia have shown quite remarkable constancy in optical properties of the glass from various parts of an individual pot, combined with very satisfactory freedom from striation or other blemish. Tests on eight consecutive melts of borosilicate crown yielded a mean refractive index (Na) of 1·5100 ± 0·00023 and barely detectable differences in dispersion. Indeed, the glasses now being produced fall in properties well within the tolerances set by the Australian Optical Munitions Panel, and ensure, therefore, an abundant supply of excellent material for munitions purposes.

OBITUARIES

The Very Rev. Sir George Adam Smith, F.B.A.

THE VERY REV. SIR GEORGE ADAM SMITH died on March 3 at his residence, Sweethillocks, Balerno, Midlothian, in his eighty-sixth year. A native of Calcutta, he was son of George Smith, who had a high reputation not only as a journalist but also as a biographer of missionaries. The young George was brought to Edinburgh, where he was educated at the Royal High School and the University. His university period does not seem to have been marked by any special distinction in examinations, though I fancy he must have taken a high place in the English class, if we are to judge by his writings. But he made valuable friendships there with such men as Henry Drummond, R. W. Barbour, Thomas Shaw (afterwards Lord Craigmyle) and R. B. Haldane, the great philosopher and war minister. His attachment to Edinburgh remained deep to the last. As a member of the Free Church of Scotland, he naturally proceeded to New College for his divinity course, when he had decided on the ministry as his life's work.

These were days of high tension in ecclesiastical circles. Smith must long have felt a strong attraction to the Old Testament, which contact with the celebrated teacher, 'Rabbi' A. B. Davidson, could only tend to accentuate. At that time the name of William Robertson Smith was on every lip in Scotland. He had imbibed in Germany what were then advanced views on the sources of the Pentateuch and on other Old Testament problems, and had set them forth in notable articles in the *Encyclopædia Britannica*. As a result he was tried for heresy by the General Assembly, and was ejected from his chair at the Aberdeen College.

George Smith, who had studied at two German universities after his Edinburgh courses were finished, and had afterwards travelled in Egypt and Syria, became an assistant minister at Brechin, but was soon appointed to carry on the work of Robertson Smith's chair, and thus had his introduction to Aberdeen, where he was destined to spend a large portion of his life. The extension of the city westwards had led to the erection of a very handsome church at the point known as Queen's Cross. The Aberdonians of those days were famous as church-goers and sermon tasters, and the members of this church were early convinced that Smith, who had been heard in various pulpits, must become their minister. He remained in this position for ten years, 1882–92, and built up a lasting reputation as a brilliant preacher and faithful minister.

Smith was able in the course of that period again to travel in Syria and east of Jordan, and subsequent visits served to confirm a knowledge of that region such as very few Hebraists in our time have attained. Not only was he the best interpreter of the Old Testament prophets to his generation, but also he had a very keen eye for the influence of geography on history. His "The Book of Isaiah" (1888–90), which grew in part out of his sermons at Aberdeen, made him known throughout English-speaking lands. The year 1896 was marked by the first of a number of visits to the United States, where as lecturer, preacher and public speaker he gained a high reputation. Perhaps the most notable of his works is his "Historical Geography of the Holy Land" which, originally published in 1894, reached a twenty-sixth edition in 1935. He set an example to other scholars by issuing revised editions of several of his works, including this, some years before his death.

On appointment to the chair of Old Testament languages, literature and theology in the United Free Church College at Glasgow, Smith had left Aberdeen in 1892. In Glasgow he found time to take an interest in social problems, such as the life of the very poor in that vast city. When in 1909 the Crown appointed him to succeed Dr. John Marshall Lang as principal of the University of Aberdeen, there was a good deal of ill-feeling in Church of Scotland circles, but this was soon lived down, especially as no one on the United Free Church side rejoiced more in the re-united Church of Scotland than Smith did. (He had been Moderator of the United Free Church Assembly in 1916–17.) It is perhaps too soon to sum up his twenty-eight years principalship, but two things may, I think, be said, that the relations between University and City were cemented as never before, and that the power of the University Court was increased at the expense of the Senatus.

If Smith was a brilliantly successful man, he did not escape sorrow. The first and second of his three sons were killed in the War of 1914–18, and his second daughter died a few weeks before her father. He was a man of deep feeling and ceaseless activity. His life was as full perhaps as that of any academic person of his time. It merits and will no doubt receive an adequate biography. His portrait was painted at least three times, by Aiken, Orpen and Souter: the second is at King's College, Aberdeen, the third at Trinity Hall, Aberdeen. A. Souter.

Lieut.-Commander L. C. Bernacchi

Lieut.-Commander Louis Charles Bernacchi was born in 1876 in Tasmania, and spent his early years in Melbourne, where his father was astronomer to the State Government. The call of physics, and especially of magnetism, therefore came naturally to him, and at the age of twenty-two he went as physicist to the first expedition which ever wintered on the Antarctic continent. This was the Newnes Expedition of 1898–99, led by Borchgrevink, which wintered at Cape Adare, within two hundred miles of the south magnetic pole.

Bernacchi had only just returned from that journey when he joined the National Antarctic Expedition of 1901–4 under Captain Scott, and he was the author of several physical reports after its return. Magnetism is often thought to be one of the more sedentary sciences, but it took Bernacchi on a thirty-day sledge trip on very short rations out over the featureless Ross Barrier with a Barrow dip circle with which he took observations each night after man-hauling all day. Scott's narrative in fact nearly always associates the word "energy" with Bernacchi's name. Two magnetic huts which he built at Hut Point were, ten years later, to prove a godsend to a marooned party of men who found building material from them, bricks for blubber stoves, lamps and copper sheets and brass tubes, so that his name became a household word for anyone seeking such things. There was even cement in not too desperate a condition.

Returned from the south, Bernacchi travelled again, this time in tropical regions, but a few years later found him forsaking physics and the wilds for a life in the City of London. But his interest in polar work never diminished, and in one way or another he was associated with most of the later expeditions.

His energy and almost restless interests took him into many fields—economics, civics and politics—as well as leading him to serve on many committees and councils.

After the War of 1914–18, in which he served in a special branch of the R.N.V.R., his polar interests crystallized in a very practical form by his taking a leading part in the formation of the Antarctic Club, of which he was the senior member. It is the pleasant custom of that Club at its annual dinner for the president to take wine in turn with the representatives of each successive expedition to the south. No member of the Club is likely to forget the sturdy figure with its genial smile which year after year rose to the first call of the evening: "The President wishes to take wine with the member of the Southern Cross Expedition of 1899, Commander Bernacchi".

Frank Debenham.

Dr. Adrien Loir, M.B.E.

A direct link with the life and work of Louis Pasteur was severed by the death in Paris of his nephew, Dr. Adrien Loir, on December 16, soon after he had entered his eightieth year. His father, who was professor of chemistry at the University of Lyons, trained him in laboratory technique so that he might help Pasteur in his experimental work. The youth was fortunate in having been chosen by his uncle to accompany him in September 1882 to Bollene in the Department of Vaucluse, where Pasteur and Thuillier, during the next two and a half months, investigated an outbreak of *rouget* (swine erysipelas). During 1882–88 Adrien Loir assisted Pasteur in the little laboratory in the Rue d'Ulm. This was a notable period in the active life of Pasteur, for it included his researches into the treatment of hydrophobia in man and the prevention of anthrax in domesticated animals.

Dr. Loir helped to establish a number of Pasteur institutes in various parts of the world: in St. Petersburg in 1886; in Sydney in 1889; and in 1893 in Tunis, where he remained as director for nine years. He held a chair in the University of Montreal during a two-year stay in Canada, and he then returned to France on his appointment in 1909 as medical officer of health of Havre; he continued in this post until his retirement in 1939.

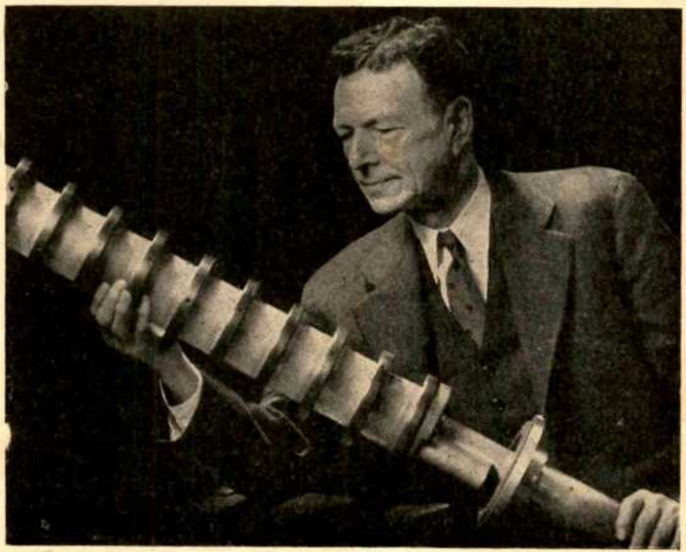
Loir published papers on public health problems such as infant mortality and the prevention of typhoid fever; and he had an international reputation for his knowledge of methods for reducing the rat population in seaports. He was hopeful that good results might be obtained by the use of special breeds of rat-catching cats, but later he realized that the prevention of rat infestation and indirectly of the spread of plague infection consists essentially in applying general hygienic measures and, in particular, in making it impossible for rats to find food and shelter.

Dr. Loir proved to be so helpful to the British authorities in the War of 1914–18, when Havre was an important base for British troops, that he received the award of the M.B.E. for his services. Many honours and distinctions, including the degree of doctor of laws of the University of Glasgow, were bestowed upon him during his varied and useful career.

NEWS and VIEWS

Dr. W. D. Coolidge : Duddell Medallist

THE eighteenth Duddell Medal of the Physical Society has been awarded to Dr. William David Coolidge in recognition of his pioneer work in the production of ductile tungsten and, more especially, of his invention and subsequent development of the hot-cathode high-vacuum X-ray tube which is everywhere known by his name. The medal was formally presented to him on May 1 by Viscount Halifax, H.M. Ambassador in Washington, at a dinner of the American Physical Society at Baltimore. Born in 1873, Coolidge began life on a farm in Massachusetts. He found means of entering the Massachusetts Institute of Technology, where he graduated in 1896 and remained until 1905, except for a short period at Leipzig. He then joined the staff of the Research Laboratory of the G.E.C., Schenectady, N.Y., becoming assistant director in 1908, associate director in 1932, and finally director of research and vice-president of the Company in 1940. He has been widely honoured both in his own country and in Europe: of several universities he has received honorary degrees, and of many learned societies he is an honorary member or a medallist; in Great Britain he has received the Hughes Medal (1927) of the Royal Society and the Faraday Medal (1939) of the Institution of Electrical Engineers.



DR. W. D. COOLIDGE

The Coolidge tube is described in his original paper as "an X-ray tube with pure electron discharge." Unlike the older cold-cathode gas tubes, it affords exact control of both intensity and 'hardness' of the radiation through the adjustments of the filament current and the accelerating potential difference, and operates continuously without change in either respect. During the War of 1914–18, Dr. Coolidge produced complete X-ray field installations including specially designed tubes of large thermal capacity, and later he developed self-contained oil-immersed outfits, which became widely applied in dentistry and in industrial laboratories on account of their easy manipulation. For high voltages he developed a multi-section tube with intermediate tubular electrodes for step-by-step acceleration of the electrons; in the accompanying photograph Dr. Coolidge is holding a million-volt tube of this type. Such tubes have been used for deep therapy under closely controlled conditions, and for the examination of materials in industry. In other tubes of this type the electron beam is made to emerge through a 'window' in the tube, and its effects have been investigated.

Ministry of Works and Planning

THE Ministry of Works and Planning Bill, which received its second reading in the House of Commons on April 29, while recognizing the principle that private profit must not be allowed to regulate the surroundings and conditions of our life after the War, is, as the Paymaster-General admitted in his speech, a very small step towards the solution of problems of planning. The purpose of the Bill is to provide for the transfer to the Minister of Works and Planning of all the existing functions of the Commissioners of Works and the Commissioners of Public Works in Ireland, and of the existing town and country planning functions of the Ministry of Health (but not its housing powers). The precise relations of the Minister of Works and Planning and the Paymaster-General are obscure, nor is it clear how far the transfer of powers goes. The Bill is, however, a step forward towards the creation of the central authority for planning in Great Britain, put forward by the Uthwatt Committee in its first recommendations.

British Reconstruction Associations

A BROADSHEET entitled "British Reconstruction Agencies" recently issued by P E P (Political and Economic Planning) affords a valuable supplement to the summary of research activities in this field included in the "Destruction and Reconstruction" issue of the *Architectural Review* of last July. Apart from its handier form for reference, the broadsheet includes, in addition to particulars of official agencies for physical reconstruction and of committees and voluntary organizations concerned with particular aspects, notes on the Inter-Allied Relief Bureau groups working for the Allied Governments, and organizations for the study of international reconstruction. An introductory note stresses the importance of a bold reconstruction policy as an essential part of the War effort. This was emphasized by Sir Stafford Cripps early in March and is one of the keynotes of an admirable report "The Old World and the New Society", issued by the Labour Party last month. The greatest weakness of British studies on reconstruction at present, says the broadsheet, is that they are not clearly enough linked with the War effort, and while many regard 1942 as the decisive year of this War, fewer seem aware that it may equally be the decisive year for the peace. Both may be lost if we cannot now convert the fight of the United Nations into a genuine crusade for a supreme moral principle and for the building of a people's civilization out of the civilization of a privileged few. Great Britain in particular needs to grasp this relationship of reconstruction policy to the War effort, and to recognize that the vision of a new order at home and abroad is an indispensable weapon both in the waging of a war and in the winning of a peace.

The United States and the War

Written before the United States entered the War "The Arsenal of Democracy" (Oxford Pamphlets on World Affairs, No. 53. London: Oxford University Press. 4*d*. net) still gives a pertinent account of the economic contribution of the United States towards the defeat of the Axis powers. After describing the movement of American opinion towards aid to Britain and her Allies, and the successive stages of American action before and after the passage of the Lease-Lend Act, Mr. A. J. Brown discusses the war-potential of the United States and its mobilization. His pamphlet gives a lucid account of the problems of the transfer of a peace-time economy to a war-footing and, if supplemented by current articles of the type appearing in recent issues of *Fortune*, should enable the reader to assess reasonably the significance of the bottlenecks of machine tools, skilled labour and raw materials. The labour and administrative problems are clearly displayed and the American contribution in ship-building, aircraft production and other supplies is fairly indicated; there is a useful appraisal of the relative strength of Great Britain, the United States and the U.S.S.R. in comparison with the Axis powers and with special reference to the time factor.

Academy of Sciences of the U.S.S.R.

A general meeting of members and corresponding members of the Soviet Academy of Sciences was held in Sverdlovsk, in the Urals, during May 2–7, to discuss the plan of scientific research work for 1942. The following papers were read: "Urgent Tasks of Science in Mobilizing the Resources of the Eastern Districts of the U.S.S.R. for the Needs of Defence", by Profs. Komarov and Bardin; "The Tasks of Social Science in the War", by Prof. Alexandrov; "Some Fundamental Problems of Agricultural Science", by Prof. Lyssenko; "Physics and the War", by Prof. Joffe; "Biology and War", by Prof. Orbeli; "The Teutonic Order, its Early Successes and Final Defeat", by Prof. Tarle; "Historic Documents of the Red Patriotic War", by Minsky. The meeting also discussed the adjustment of the Academy's work in accordance with the needs of the War.

Medical Progress in China

In a recent lecture published in the *Asiatic Review* of April, Dr. W. H. Woo gives an interesting survey of medical progress in China from the earliest times. The origin of native medicine can be traced back to the earliest Chinese emperors, who flourished three or four thousand years ago. So early as the Chou dynasty, about 700 B.C., medicine had reached a high degree of development, and four kinds of medical man—physician, surgeon, dietician and veterinary surgeon—were distinguished. Afterwards, one of the most notable events in the history of Chinese medicine was the publication by Li Shee Chin about A.D. 1578 of a materia medica consisting of fifty-two volumes and containing not only herbs but also drugs of animal and mineral origin as well. A new medicine was introduced in 1835, being due chiefly to Dr. Parker, who founded the first hospital in China, but it was not until three quarters of a century later that Sun Yat Sen, the founder of the Chinese Republic and himself a medical man, placed medical services on a proper footing.

In 1927 a Ministry of Health was founded in China to reorganize public health centres and reform medical education. In spite of an energetic campaign against disease, the death-rate from various causes in China is still very high. According to the latest annual statistics, the infantile mortality in China is 200 per thousand, and the maternal mortality 15 per 1,000, as compared with 53 per 1,000 and 4 per 1,000 respectively in Great Britain, and tuberculosis kills 5 out of every 1,000 Chinese, while in Great Britain the proportion is ten times lower. An active campaign has been undertaken against opium smoking, and this evil would doubtless have been eradicated but for the Japanese, who encouraged the habit and distributed opium free in occupied territory. In pre-war days, medical schools in China numbered about thirty-six, but many of them have since suffered from depletion of staff and loss of laboratory equipment, to remedy which the present policy of the Ministry of Education is to confine medical education to centres in Free China.

Gold Coast Timbers

All over the Empire, wherever forests at all accessible exist, the same formula is heard expressed: "War-time conditions have brought about an increased demand for timber both locally and for export"; and the demands of the fighting forces are to a large extent responsible for this increased demand. On several occasions allusion has been made to this factor in Nature. There may occasionally be an asset to set against these often unsupervised extra fellings, one of which is mentioned in a publication of the Forestry Department of the Gold Coast entitled "Gold Coast Timbers" (Govt. Printers, Accra, 1941), issued under the name of the Chief Conservator of Forests, who had the assistance of officers of the Department in its compilation. As was the case during the War of 1914–18, especially in India and Burma, the great demands by the Army and, in the present War, largely increased demands for commercial war production, have necessitated a larger call on the tropical forests and the bringing into utilization of timbers for which there was no commercial demand in peace-time. As the author says of the Gold Coast, timber is required for many and varied purposes, and species formerly but little used have come into prominence.

It was in view of this extra demand that the present small monograph was prepared. It only purports to give a summary of existing information about some of the more important Gold Coast timbers, forty-four in number; other species in the forests not mentioned may prove as useful, it is said, in the future, even if not more useful, than some of those here dealt with. There are some 20,000 square miles of high forest and double that number of savannah forest. Some 1–1½ million acres of the high forest are classed as at present accessible. On the subject of distribution and frequency of species, enumeration surveys have been carried out to a certain degree, but it is emphasized that average figures only have been obtainable from them. This is, however, quite in keeping with the ordinary first attempts to obtain some knowledge of the stocking in the tropical forest. The suggested classification of durability and impregnation susceptibility appear to be somewhat clumsy and capable of simplification. A summary of the uses of local timbers is given. The little monograph should prove of use both to forest officer and timber buyer; and may even ensure some measure of control over the all too common unsupervised fellings in tropical forests, which have been taking place on an increased scale.

The Imperial Forestry Institute

In the seventeenth annual report, for 1940–41, of the Imperial Forestry Institute (Oxford, The Holywell Press, Ltd., 1941) it is stated that the year was the first under the new organization, one result of which is to amalgamate the Oxford School of Forestry with the Institute. The interruptions of leave and so forth naturally interfered with Colonial forest officers taking refresher courses at the Institute. As has been the case with other forestry schools, practical forestry courses had to be confined to Great Britain. The professor of forestry, Prof. H. G. Champion, was fortunate in being able to retain a certain staff at the Institute. As a consequence some degree of investigation and experimental research work was continued in sylviculture, mensuration and management, soil science (in which the valuable co-operation of Dr. M. C. Rayner of Bedford College, London, was afforded), tropical forest botany and fruit pathology.

Economy of Tin in Bearings

Since the change to Japanese control of the tin-producing regions in south-eastern Asia, the sources of about two-thirds of their supplies have been lost to the Allies. In an attempt to make this good, the Ministry of Supply has just issued a pamphlet on modifications recommended in bearing-metal practice. More than 2,000 tons of tin are used annually in Great Britain in bearing-metals, and the new suggestions, if loyally adopted, would, it is estimated, ensure a saving of 65 per cent, equal to the entire output of the Cornish mines last year. This pamphlet is available from the Non-Ferrous Metals Control, Grand Hotel, Rugby, or the Tin Research Institute, Fraser Road, Greenford, Middlesex. The white bearing-metals have been divided into four groups with 80–92, 68–75, 7–12 and 0–5 per cent of tin respectively. Alloys with 12–68 per cent of tin have very rightly been omitted entirely, as suitable alloys for practically any purpose can be found in the compositions still retained, modified, if necessary, by other additions. A long list of typical bearings is given with the class of alloy suitable for each. Alloys falling outside these groups may be used only with the approval of the Non-Ferrous Metals Control.

A further appreciable saving may be made by reducing the thickness of white metal linings, a practice which has been steadily growing for some years. As a result, especially in the automobile industry, it has been found that the thinner linings can often carry heavier loads with an increased factor of safety. Other suggestions for economy include careful segregation and collection of scrap, the use of steel bushes lined with bronze instead of solid bronze ones, and the substitution, for most purposes, of an alloy containing 85 copper, 5 tin, 5 lead, and 5 zinc for Admiralty gunmetal.

The U.S. National Academy and Calendar Reform

A poll of the U.S. National Academy of Sciences indicates a three-to-one preponderance of opinion in favour of a calendar reform which would 'even up' the lengths of the months, giving each twenty-six working days and having each month begin on a Sunday. The ballot was conducted by Prof. W. E. Castle, of the University of California, Berkeley. He received responses from 168 of them, or more than half the membership of the Academy. Of those answering, 76 per cent favoured the change, 10 per cent opposed, and 14 per cent were undecided. Of those who favoured the change, 58 per cent wanted it initiated in 1945, which is the next year that begins on a Sunday; 42 per cent were against this unless the War ends soon enough.

Earthquakes in the Pacific

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association has found the epicentres of two recent earthquakes. The first, on March 1, 1942, took place at 9h. 52·0 m. U.T. The tentative epicentre, calculated from instrumental recordings at eight observatories, was latitude 13° N., longitude 91° W., which is in the Pacific Ocean, south of San José in Guatemala (Central America).

The second shock, on March 5, 1942, at 19h. 48·2 m. U.T., had its provisional epicentre at latitude 48° S., longitude 98° W., which is in the Pacific Ocean to the west of southern Chile. The focus of this latter shock is estimated to have been at a depth of some 250–300 km., so that it might be termed an 'intermediate' shock. Earthquake shocks have been known to occur down to depths of 700 km. Both the above earthquakes occurred in regions known to be liable to earthquakes.

Demographic Census of Rio de Janeiro

The last census of Brazil showed that on September 1, 1940, Rio de Janeiro had 1,781,567 inhabitants (*J. Amer. Med. Assoc.*, Feb. 14). The decline of births was illustrated by the fact that whereas in the period 1921–1930 the births numbered 344,921, in the period 1931–1940 only 321,976 births were registered, although there was an increase in the population. In the first period there were 248,964 deaths, and in the second period 274,233. This increase, however, was not in proportion to the growth of the population. In the same periods the marriages numbered 80,545 and 106,112 respectively, though there was a decrease in the birth-rate. The population of the capitals of the Brazilian States was 5,661,091 in 1940, or 13·6 per cent of the population of the whole country. In 1920 the figure was only 8·6 per cent of the whole nation.

Institute of Fuel: Melchett Medallist

The Melchett Medal for 1942 of the Institute of Fuel has been awarded to Dr. Arno Carl Fieldner, the head of the Technologic Branch of the Bureau of Mines, Washington, for outstanding work carried out by him and under his supervision in connexion with fuel. The Melchett Medal was founded in 1930 by the first Lord Melchett, and has been presented to seven Englishmen, one American, one Frenchman, and three Germans.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Social Sciences

An editorial appeared in *The Times* of March 28 under the heading "Social Surveys", accompanied on the same day by a special article entitled "War-time Social Surveys". It was there suggested that a Social Science Research Council might be set up as a guide to the Government.

In view of recent discussions that have taken place about the establishment of such a Council, certain suggestions there put forward by the writer of the special article seem to call for comment.

Some of the most fruitful experiments in social life as well as in the practice of government spring out of the needs of war-time. No one more than myself will praise the "utilitarian objective" in science. (Incidentally, I note that the word 'science' has dropped out of "Social Science Research Council" and the word "National" has been inserted; surely a significant change.) No one will despise £40,000 annually coming from the Government "for the Advancement of Science". But I do sincerely trust that any Social Science Research Council that may be set up after or during this War will not be a Government-controlled body, but an academic body.

The Economic Advisory Council or its successor is appropriate to meet, under Cabinet control, the Cabinet's need. Politicians and Civil Servants are not generically inspired by the pure desire to know; and the sharp distinction between science and 'business of State', menaced in every direction of modern life, is far more basic in the social than in the physical or medical sciences. This does not mean that an academic Social Science Research Council, enjoying the same independence as the Royal Society, cannot be of immense aid to a Government that refers problems to it for research, in just the same fashion as its counterpart, the American Social Science Research Council has been.

George Catlin.

2 Cheyne Walk,
Chelsea, S.W.3.
April 28.

The Solar Corona

The difficulties which have so far been experienced in working out a physical theory of the solar corona (*vide* Rosseland, "Theoretical Astrophysics", Chap. 14) have apparently been increased by the discovery of Grotrian and Edlén that many of these lines are due to forbidden transitions of highly stripped atoms of iron and nickel having the constitution $3\,p^x$ ($x = 1$ to 5), and to calcium atoms having the constitution $2\,p^x$; thus the line 5303 is produced by an iron ion which has lost as many as thirteen electrons. After learning of this extraordinary discovery from an article by Prof. H. N. Russell in the *Scientific American* of August, 1941, I undertook a critical examination of the available spectroscopic data, and can confirm that the claim is a sound one.

Prof. Russell has pointed out that the solar corona apparently shows a predominance of the very same elements which are found prominently in iron-meteors, but to me the coincidence appears to be only fortuitous. From extant observations we can draw a fairly safe conclusion that the lines cannot be due to large-scale meteor flashes; but the stripped atoms responsible for the lines are streaming outwards with high velocities. This conclusion follows (1) from the work of Lyot[1] (1937) that the breadth of the coronal lines, which is unusually large for a temperature of 6,000°, *increases* as we approach the solar limb; (2) from the work of Waldemeier[2] (1938), in which it is shown that the great breadth of the coronal lines may be explained as being due to radial streaming of particles, and the greater the breadth, the greater is the velocity. In the inner corona, the velocity is reduced to nearly 60 km./sec., but it must be much larger in the chromosphere, and in the reversing layer, where as will be shown presently, the particles originate.

If these conclusions are granted, we have next to find out what physical processes give rise to such highly stripped atoms and send them through the solar envelope with such tremendous velocities. It is obvious that we have to exclude thermal or photo-electric ionization and generally all extra-nuclear processes.

The only plausible hypothesis appears to be that these highly stripped atoms are produced in a nuclear reaction, analogous to uranium fission, occurring somewhere inside the reversing layer. It is known from investigations on uranium fission that the fission fragments separate from each other with energies of the order of 80 Mev. corresponding to a velocity of 6–8 cf, where c is the velocity of light, f is the Sommerfeld fine-structure constant (cf is the velocity of the electron in the first H-orbit). These fission fragments are known from experiments by Böggild, Lauritsen and others[3] (1942) at Prof. Bohr's laboratory at Copenhagen to be endowed with a high net positive charge at the moment of their production; in fact, they are found to have lost all those outer electrons the orbital velocities of which are inferior to their own velocity of separation (6–8 cf). An iron atom which retains only 10 electrons, namely, Fe^{+} $1s^2 .\ 2s^2 .\ 2p^6$, . . . should have a velocityof 6·5 cf at the moment of its production and hence its energy should be 60 Mev. There is one difficulty in this hypothesis. So far only ^{238}U, ^{235}U, ^{232}Th and ^{231}Pa have been shown to be capable of fission (Bohr and Wheeler[4], 1939), and experimentally fission into two fragments only has so far been demonstrated. But this difficulty is not insuperable; on energetic grounds, fission into a larger number of fractions, say three or four, is possible. As for the presence of the fission elements in the sun, their spectra is so complex that no serious attempt at identification has yet been undertaken.

In any event, the presence of Fe^{+13} or Ni^{+15} moving through the solar envelope with large velocities is a demonstrated fact, and one can calculate the range and electron exchange of these particles. If we make the reasonable hypothesis that the iron ions start at the moment of their production as Fe^{+16} $1s^2 .\ 2s^2 .\ 2p^6$ they would have an initial velocity of 6·5 cf. Their career through the solar atmosphere is analogous to that of α-particles, or better of fission fragments through the cloud chamber. They would be losing energy all the way because they ionize the solar atoms with which they come into contact according to the process known as ionization by collision. The solar atoms from which α-rays are expelled may b supposed to be mostly hydrogen atoms, and on reasonable assumptions, the range comes to abou 10^{21} hydrogen atoms. The particles must, therefore originate inside the reversing layer.

Further, there will be a lively interchange of electrons between the stripped ions and the solar atoms according to the processes described by Jacobsen[5] (1930), and Kramers and Brinkmann[6] (1930). As the velocity decreases, more and more electrons will be acquired, in the normal or metastable states, and ultimately, the ion emerges in the inner corona where alone it has a chance of being observed as an ion with a $3p^x$-structure, with much-reduced velocities (60 km. per sec.).

It is interesting in this connexion to recall the following intuitive remarks of the late Lord Rutherford: "In the furnace of the Sun and other hot stars, the electrons, protons, neutrons, and atoms present must be endowed with high average velocities owing to thermal agitation. It is thus to be expected that the processes both of disintegration and aggregation of nuclei, such as are observed in the laboratory, should be operative on a vast scale for all nuclei, and that a kind of equilibrium should be set up between these two opposing agencies of dissociation and association for each type of atomic nucleus."

The nuclear reaction envisaged here is of a type which was not suspected when Lord Rutherford wrote the above passage. But it is quite possible that nuclear reactions of the type contemplated by Lord Rutherford are also constantly taking place, even on the surface of stars. The occurrence of the He^+-line, 4686, in the lower chromosphere, and of He-lines in the upper chromosphere, and the vanishing of the He-lines in the reversing layer have long remained unexplained puzzles (Perepelkin and Melnekov[7], 1935). For this case probably some kind of nuclear reaction which gives rise to α-particles is responsible; the α-particle in its passage through the solar envelope will first capture an electron, becoming He^+ in the normal or some excited state, then capture another electron, and become He in the normal or excited state. The process was first discovered in the cloud-chamber studies of α-rays by Henderson and Rutherford[8], who showed experimentally that during the last centimetre of its path, the α-particle may gain an electron and then again lose it nearly a thousand times. During the last few millimetres, He^+ may gain and lose electrons a large number of times.

The outer corona is now believed to consist entirely of electrons, but difficulty has been found in tracing the origin of these electrons. They are probably the δ-rays expelled from solar atoms by the highly-stripped iron or nickel ions in the upper chromosphere.

A complete physical theory of the solar corona on the above lines has been worked out and is in process of publication in the *Proceedings of the National Institute of Sciences of India*.

If the consideration presented here prove to be correct, the occurrence of coronal lines is a fingerpost showing that nuclear reactions are taking place even on the gaseous envelope of the sun, and possibly also of stars, and may in some cases influence observable stellar phenomena to a not inconsiderable extent.

M. N. Saha.

University College of Science,
Calcutta. Feb. 27.

Lyot, *L'Astronomie*, **51**, 203 (1937).
Waldemeier, *Z. ast. Phys.*, **15**, 44 (1938).
Böggild, *Phys. Rev.*, **60**, 827 (1942).
Bohr and Wheeler, *Phys. Rev.*, **56**, 426 (1939).
Jacobsen, *Phil. Mag.*, **10**, 401 (1930).
Kramers and Brinkmann, *Proc. Kon. Akad. Amsterdam*, **30**, 973 (1930).
Perepelkin and Melnekov, *Pulkovo Bull.* No. 122, 14 (1935).
Henderson, *Proc. Roy. Soc.*, A, **102**, 496 (1923).

History of the British Thermal Unit

A certain amount of interest appears to have arisen of late as to the history and definition of the British thermal unit. The position so far as we have been able to ascertain it is set out below, and it would seem that the British thermal unit under that name does not appear to have any very definite origin or legal definition.

In the early literature of Great Britain on the equivalence of work and heat, the unit of heat used was that which has since become known as the British thermal unit, but by Joule, Thomson, Rankine and others of that time it was simply referred to as a "heat unit". The Oxford Dictionary gives 1876 as the earliest date of use of the term British thermal unit. This occurs in "Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum, 1876" under item 1056. The complete entry (p. 273 of 3rd Edit.) is:

"*Hargreaves's Thermo-radiometer*, for measuring loss of heat by radiation from walls of furnaces, sides of steam boilers, etc.

"James Hargreaves.

"The silver-plated copper vessel is filled with water and enclosed in the case, the blackened face then being exposed for a given time (say, five minutes) to the radiating surface, a thermometer inserted in the neck of the vessel shows the elevation of temperature due to radiation. The heat is calculated as follows, either in calories or British thermal units, $\frac{Ws(T-t)}{am} = x$, where Ws = weight and average specific heat of vessel and contents, t = temperature of same before exposure, T, temperature of same after exposure, a = area of blackened face of vessel and m, time of exposure, whence may be calculated the amount of fuel necessary to replace the heat lost by radiation."

It would seem that this may have been a chance use of the term *British* thermal unit, as a means of distinction from the calorie, for reference to other works of about that time has shown that Lardner and Loewy's "Heat" (1877), p. 97, gives the unit, but no name, Cotterell in "The Steam Engine considered as a Heat Engine" (1878), p. 8, speaks of the quantity of heat being measured in thermal units. Prof. Everett in his "Units and Physical Constants" (1879) makes no mention of the British thermal unit, nor does it figure in the article on "Heat" contributed by Sir William Thomson to the 1880 edition of the "Encyclopædia Britannica". Furthermore, William Anderson, in his Howard lecture on "The Conversion of Heat into Useful Work" delivered on December 5, 1884, said: "I shall now explain that the quantity of heat or energy of molecular vibration which raises one pound of water 1° F. is called the British unit of heat" (*J. Soc. Arts*, 33, 565; 1885); on p. 576 he uses the abbreviation *u* for this unit.

In Prof. Jamieson's "Text Book of Steam and Steam Engines", 10th Edit. (1895), p. 32, however, one finds the definite statement: "The standard unit now adopted in this country is called the British Thermal Unit and is the quantity of heat required to raise 1 lb. of water by 1° F. when at its maximum density, i.e., from 39·1° to 40·1° F." (The temperature used by Joule when defining his "heat unit".)

Access to earlier editions of this work has not been possible, but it certainly appears that the British thermal unit as we know it to-day had become recognized by 1895. Writing on December 5 of that year, Prof. H. L. Callendar stated (British Association Report 1896, p. 159): "For steam engine work undoubtedly one of the most important units at present in use is the British thermal unit, or pound degree Fahrenheit."

The precise temperature at which the rise of 1° F. is to be measured does not appear to have been specified in any legal definition. The Gas Regulation Act, 1920, merely states: "The calorific value of gas means, for the purposes of this Act, the number of British thermal units (gross) produced by the combustion of one cubic foot of the gas measured at sixty degrees Fahrenheit under a pressure of thirty inches of mercury and saturated with water vapour."

The Act mentioned was based on recommendations of the Fuel Research Board, and the relevant reports have been published by the Department of Scientific and Industrial Research in a pamphlet entitled "The Therm" (H.M. Stationery Office, 1922). The therm is defined in the Act as 100,000 British Thermal Units.

Hyde and Mills in the introduction to their book "Gas Calorimetry" (1932), after referring to the Gas Regulation Act, 1920, go on to state: "The definition of a British Thermal Unit presents some difficulty since opinion differs as to the temperature at which it should be defined. For the purposes of this book, however, it is desirable that the values of a British Thermal Unit and a kilo-calorie should be easily convertible one to another. . . . The British Thermal Unit is therefore defined as the amount of heat required to raise the temperature of 1 lb. of water at 59° F. by 1° F."

In addition to this definition and that of Prof. Jamieson quoted earlier, other workers including Sir Alfred Ewing, "Dictionary of Applied Physics", 1, 922, and "Thermodynamics for Engineers", have defined the British Thermal Unit as 1/180 of the quantity of heat required to warm 1 pound of water from the melting point to the boiling point. This last is the definition given by the British Standards Institution for the mean British Thermal Unit in *B.S.* 205 (1926 and 1936), where the British Thermal Unit is defined as the quantity of heat required to raise the temperature of 1 lb. of water from 60° F. to 61° F.

The similar effect of variations in the specific heat of water on the value of the calorie was brought to the notice of the British Association in 1895 in a paper reproduced in the *Phil. Mag.* (40, 431; 1895). The suggestions made in this paper received considerable publicity and the correspondence was reproduced in the Report of the British Association for the following year.

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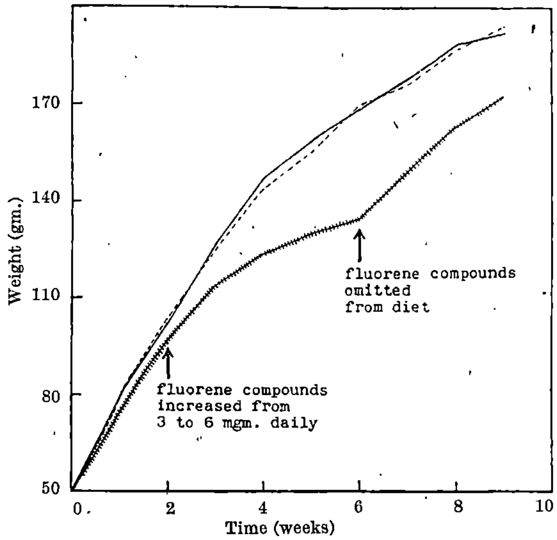
2-Aminofluorene as Growth Inhibitor for Bacteria and Rats

IN an effort to discover common mechanisms responsible for growth-inhibition of both tissue cells and bacteria, colloidal solutions of carcinogenic compounds (including 1-2-5-6 dibenzanthracene, 3-4 benzpyrene, methylcholanthrene, dimethyl yellow) have been tested systematically by us for possible bacteriostatic action. No very significant results have been obtained.

Recently, Wilson, DeEds and Cox[1] discovered the carcinogenic action of the insecticide, 2-acetyl aminofluorene. Its action is of peculiar interest since, when given orally, multiple tumours of different histological types developed in some rats. We found that 2-aminofluorene dissolved in nutrient broth had a bactericidal or strong bacteriostatic effect on certain bacteria and of these *Staphylococcus aureus* was chosen as the standard test organism. Since the corresponding acetyl compound has a considerable inhibitory effect on the growth-rate of rats, we decided to investigate related fluorene compounds in order to determine the effect of alterations in the chemical configuration on both the growth-rate of rats and that of the staphylococcus. We synthesized the following compounds: 2-aminofluorenone, 2-amin fluorenol, 9-aminofluorene and the correspondin acetyl compounds. The latter were used in rat-feedin tests and the compounds with a free amino group i the *in vitro* bacterial tests. 2-acetyl aminofluorene unsuitable for *in vitro* work owing to its poor sol bility in nutrient broth. Since, however, there is n reason to think that the acetyl group plays any pa in its specific *in vivo* action, it seemed justifiable t compare the action of the free amino compoun *in vitro* with that of the acetylated compounds *in viv* None of the compounds mentioned, with the e ception of 2-acetyl aminofluorene, had any significa growth-inhibiting action on rats (see accompanyi graph). The effect of the related compounds bacterial growth was similar except that 2-amin fluorenone had a definite bacteriostatic action, whi was, however, feeble compared with that of 2-amin fluorene (see accompanying table).



EFFECT OF FEEDING 2-ACETYL AMINOFLUORENE AND 2-ACETYL AMINOFLUORENONE ON GROWTH-RATE OF RATS.

Diet: whole milk powder (30 per cent) and bread; cod liver oil (0·2 ml. daily) and cabbage once a week. Full line, controls; broken line, feeding on 2-acetyl aminofluorene; crossed line, 2-acetyl aminofluorenone.

THE EFFECT OF 2-AMINOFLUORENE (1/10,000) AND 2-AMINOFLUORENO (1/10,000) ON THE GROWTH OF *Staphylococcus aureus*. INOCULU 10^6 COCCI/ML. MEDIUM

	Appearance of turbidity (hr.)	Degree of turbidity. Incident light absorbed (per cent) after (hr.) 13	16
Control culture	8	75	85
2-aminofluorenone	13	25	78
2-aminofluorene	45	0	0

The results indicate the importance of the presence of the two reacting hydrogen atoms in the 9-position, in combination with the amino group in the 2-position, in determining the growth-inhibiting and possibly the carcinogenic activity of 2-aminofluorene.

The possibility of studying the action of a chemical carcinogen by its effect on bacterial metabolism has obvious advantages in the analysis of the mechanism involved.

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April 16.

[1] Wilson, R. H., DeEds, Floyd, Cox, A. J., *Cancer Research*, 1, 595 (1941).

Time of Collapse of a Soap Bubble

A spherical soap bubble of radius R blown at the end of a uniform glass tube of radius a and length l will gradually deflate itself and disappear. Its time of collapse τ can be computed on the assumption that the gas inside the bubble of viscosity η passes out of the tube in streamline flow under the pressure excess in the bubble. In a spherical soap bubble of radius r, this pressure excess is $4T/r$, where T is the surface tension of the soap solution. Hence from a consideration of the viscous flow of a gas in a tube under a small pressure difference between its ends, it follows that,

$$-d\left(\frac{4}{3}\pi r^3\right) = \frac{\pi a^4}{8\eta l}\,\frac{4T}{r}\,dt\,;$$

whence

$$-\int_R^0 r^3 dr = \int_0^\tau \frac{Ta^4}{8\eta l}\,dt.$$

Hence $\dfrac{R^4}{\tau} = \dfrac{Ta^4}{2\eta l}$.

It has been found experimentally possible to blow spherical soap bubbles of more than 5 cm. diameter, the shape of which, in spite of gravity, can be considered to be spherical to a good approximation. When the bubbles are suitably blown, the vertical and horizontal diameters do not differ by more than a quarter per cent even in large bubbles of about 8 cm. diameter. The experimental results have confirmed the above relation, which therefore opens up a new method of estimating the surface tension of different soap solutions. Under suitable experimental conditions, a determination of the viscosities of certain gases *or* their effect on the surface tension of soap films is also rendered possible.

Experimental results will soon be published elsewhere.

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Jan. 12.

Enzymatic Synthesis of Levan

Study of the formation of micro-organisms of polysaccharides from sucrose has been hampered by he absence of a satisfactory technique for the cell-ree isolation of the enzyme catalysts concerned[1]. This obstacle has now been removed. The separation of a dextran-synthesizing enzyme from *Leuconostoc mesenteroides* has been reported recently by Hehre[2]. t is the purpose of the present note to report the isolation from *Bacillus subtilis* and Aerobacter of an enzyme or enzymes which act on sucrose with formation of levan.

In sucrose-agar, colonies of *Bacillus subtilis* induce formation of levan to some distance from their site of growth[3]. When cell-free agar pieces from the vicinity of such *B. subtilis* colonies are aseptically removed to sterile sucrose solutions, they cause the gradual appearance in the fluid of a pronounced opalescence accompanying the formation of a polysaccharide which is identical in chemical and physical properties with levan. After 24 hours incubation, the amount of polysaccharide formed was considerable (300 mgm./per cent). When ground up in sucrose solution, a partial extraction of synthesizing enzyme from its agar matrix was obtained. This technique proved ill-suited, however, to the isolation of the synthesizing enzyme on a considerable scale.

A further and more convenient source of a levan-synthesizing enzyme was found in a levan-forming strain of Aerobacter. This organism, unlike most of the aerobic spore formers, is easily killed by narcotics. Cell-free autolysates prepared from an aqueous suspension of the cells by incubation with a little thymol in chloroform and subsequent centrifugation actively synthesized levan from sucrose (393 mgm. per cent in 40 hr.). On drying over Drierite in vacuum a stable water-soluble powder of considerable synthetic activity was obtained.

Control tests showed definitely that synthesis by the different enzyme preparations which have been described had occurred in the complete absence of living bacterial cells.

It seems reasonable to hope that with the aid of these enzyme preparations, new insight will be obtained into the sequence of reactions leading to levan formation. A full report on the properties and activity of the levan-synthesizing enzyme preparations will be presented elsewhere.

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Feb. 15.

[1] Harrison, Tarr and Hibbert, *Can. J. Res.*, 3, 499 (1930).

[2] Hehre, *Science*, 93, 237 (1941).

[3] Beijerinck, *Folia Microbiologica*, 1, 377 (1912).

Meiosis in Drosophila

Up to now students of Drosophila have regarded meiosis in the male as almost inaccessible, and have, therefore, confined themselves to the genetical investigation of essentially cytological problems. This is due to the belief that meiosis was completed in the pupa and that only the actual spermiogenesis takes place in the adult.

I have worked principally with aceto-orcein smear preparations of testes of *D. subobscura*. Meiosis in this species starts in the fully grown larva and continues in waves throughout the whole of pupal and adult life at least up to a fortnight after eclosion. It subsides during periods of differentiation, for example, when the vasa deferentia begin to grow, and during periods of great stress, for example, on emergence, so that no divisions occur in young males up to two days of age.

In view of these facts Huettner's statement[1] that "adult males of *D. melanogaster* are useless for the study of meiosis" seemed improbable. I, therefore, made preparations from males of our Oregon line more than two days old. The testes exhibited all stages of spermatogenesis.

In the course of various experiments, I have been able to study mitosis and meiosis in *XY*, *XO*, and *XYY* adult males of *D. subobscura* and in *XY* males of *D. melanogaster*. Primary non-disjunction of the sex chromosomes was observed in both species.

It is hoped that by using adult Drosophila males, problems which demand the simultaneous classification of phenotype and chromosome type may now be tackled with greater ease.

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at Rothamsted Experimental Station,
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April 10.

[1] Huettner, A. F., *Z. Zellf. u. mikr. Anat.*, 2, 615 (1930).

Proteins Susceptible to Cold in Pathological Sera

In the blood of dogs infected with kala-azar, proteins are precipitated on cooling to room temperature (20° C.), or better still when allowed to stand in the ice-box (5° C.) overnight. This protein belongs to the pathologically increased euglobulin fraction. In twenty-one sera investigated (six cases) the cold fraction test was positive. In typical specimens, turbidity soon followed by precipitation sets in within a quarter of an hour of standing in the ice-box. The protein precipitated from kala-azar serum on cooling (cold fraction) is defined as the centrifugable protein fraction which precipitates after 24 hr. at 5° C., and is redissolved by warming to 37°–50° C. This cold fraction ranged between traces of turbidity which could not be determined quantitatively to maximal 3 gm. per 100 c.c. of serum. Typical cases gave tests as shown in the accompanying table:

Case	Total Prot.	Alb.	Glob.	Eu-glob.	Fibrin-ogen	Cold fract.	Dilution fract.*	Formol-gel
Dog 1	10·22	2·39	7·83	4·59	1·1	0·28	9·96	+
Dog 2	10·25	1·87	8·38	3·90	1·0	0·63	0·19	+
Dog 5	11·30	2·75	8·55	4·49	0·94	0·40	0·43	+
Dog 6	10·31	3·25	7·06	1·91	—	0·70	turbid	+
Human	6·06	1·72	4·34	1·81	—	+	+	+

* Dilution fraction: Dilution 1 : 30 with distilled water, centrifugable precipitate determined after 5 minutes standing at 20° C.

No clear-cut parallelism could be established between cold fraction Brahmachari and formol-gel tests. In Dog 1, identical cold fraction values were found simultaneously in serum (1·23 per cent) and exudate from artificial pleuritis (1·4 per cent).

The cold fraction is completely redissolved by warming to 37° C. In samples obtained from animals with particularly heavy infections, a relatively small fraction precipitates which is insoluble even at 60° C. If freshly drawn serum is allowed to stand at 37° C. for 24 hr. or at 60° C. for 30 minutes, precipitation in the cold occurs no longer. If the cold fraction is allowed to stand in its serum at 5° C. for a prolonged time, an increase or a decrease is observed; constant cold fraction values are scarcely ever obtained. A portion of this fraction does not redissolve on warming to temperatures up to 60° C. The cold fraction proved to be markedly labile.

In 0·9 per cent saline the cold fraction dissolves readily, and in this medium it is especially sensitive to temperature. At 70° C., irreversible heat precipitation occurs. The optimum *p*H, both of cold and heat precipitation, is at *p*H 5·7–6·2 (phosphate buffer). This fraction is particularly susceptible to diminution of salt concentration of the solvent.

Although the serum contained cold fraction, none was found in saline extracts obtained from tissues (lymph nodes, bone marrow, spleen, liver) of a dog suffering from kala-azar.

Hamsters infected with kala-azar showed no hyperproteinæmia and no abnormal proteins in the serum. The euglobulin values were normal. In dogs, visceral leishmaniasis is markedly chronic and is accompanied by a marked stimulation of the reticulo-endothelial cells; in hamsters infected with the strain of *L. donovani* used in these experiments, no such stimulation of the reticulo-endothelial system is produced.

We investigated five treated cases and one untreated case of human kala-azar. In all sera (eleven investigations) the cold fraction test was positive, but far less than in canine cases.

A large number of other pathological human sera was investigated as to the occurrence of the cold fraction. Only in a few cases of chronic infections (tuberculosis, malaria, osteomyelitis) was a weakly positive cold fraction test encountered. However, out of seven cases (twenty sera investigated) of endocarditis lenta, five cases gave positive cold fraction tests.

Precipitations which occur in plasma at low temperature are being investigated.

We are indebted for this material to Prof. S. Adler and Dr. J. Tchernomoretz, who kindly provided us with a steady supply of kala-azar dog serum.

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Reversible Quenching by Oxygen of the Fluorescence of Polycyclic Hydrocarbons

In their recent letter in Nature[1], Drs. H. Weil-Malherbe and J. Weiss have overlooked the work of Bowen and Williams[2], in which the reversible quenching by oxygen of the fluorescence of solutions of fifteen aromatic hydrocarbons was measured. The fluorescence of naphthalene was found to be quenched at least as powerfully as the 3 : 4 benzpyrene to which attention is directed. The absolute fluorescence efficiencies of the hydrocarbon solutions were compared with the absolute rates of oxidation, and it was found that for naphthalene, anthracene, rubrene etc., the permanent oxidation was much less than corresponded to the quenching effect, proving tha a reversible dissociation of the quenching complex hydrocarbon - oxygen into the original molecule must occur. The general relations between fluorescence quenching and actual photo-oxidation by oxygen appeared to be of a very complex nature.

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Oxford.

[1] Nature, 149, 471 (1942).

[2] *Trans. Faraday Soc.*, 35, 765 (1939).

INFLUENCE OF SNOBBERY ON THE PRACTICE OF MEDICINE

THE lecture entitled "The Hand in Healing: a Study in Greek Medicine from Hippocrates to Ramazzini", delivered before the Royal Institution on December 4 by Prof. B. Farrington, professor of classics at University College, Swansea, has now been published by the Institution. In it Prof. Farrington discusses three topics: (1) the decline of anatomy and surgery after Galen; (2) the limitation of ancient medicine to the rich and the professional classes; (3) the invasion of medical science by *a priori* philosophical concepts. His object is to show that the decline in social status of the manual labourer (*a*) prevented the development of physics and chemistry, and (*b*) caused a gradual deterioration of anatomy and surgery. That chemistry and physics, in the modern sense, were practically unknown, that surgery after Galen was separated from medicine and rapidly declined, are admitted truths; the novelty in Farrington's paper is his finding the cause of these phenomena in the Greek dislike of what were called "banausic" occupations. This is a most ingenious suggestion, almost certainly containing an element of truth. The evidence, however, should be closely examined before the hypothesis is accepted; in a few places Prof. Farrington appears to have misunderstood it.

The meaning of "banausic occupations" raises a thorny question. "Banausia" seems to have been an Athenian conception, appreciated perhaps throughout Greece but to a less degree than at Athens. It signifies not so much a prejudice against manual work in itself—for full honour was given to painters, sculptors, soldiers and farmers—but only against wearying trades involving long hours in conditions that ruin the worker's physique and dull his intellect. Moderns feel a similar prejudice against certain monotonous operations in factories. Such pursuits *are* harmful; we are learning that "banausic" work should be done by machines rather than by men and women. The dislike of the Greeks was the result of a healthy instinct, but they are to be blamed because while accepting the facts they relegated "banausic" labour so far as possible to slaves, in order to have the leisure to live full lives as citizens. The first man to interest himself in occupational disease was apparently Paracelsus, who wrote a treatise on the ailments of miners. Be all this as it may, it would be difficult to show that medicine or even surgery was ever ranked among the "banausic" arts; by the time surgery came to be despised, the Greek ideals that gave rise to "banausia" had ceased to exist.

On p. 15 Prof. Farrington states that "the Hippocratic medicine was already (fifth century B.C.) limited in its application to a section of the people", that is, to the idle rich. Yet medical historians such as Rossignol (in 1858), Littré and Couch (in 1934) have pointed out that the patients of the Hippocratic clinical histories are for the most part humble folk, being indeed often slaves. This fact has to be reconciled with Plato's statement that for slaves there were slave doctors.

Prof. Farrington also takes the view that the long treatise "Regimen" was a medical text-book written by a typical Hippocratic physician for general use. This is extremely doubtful. It was probably the work of a professional trainer, who with a special purpose wrote for a special public—those who, fearing lest their work should be interrupted by a threatened illness, wished to 'nip it in the bud'. To call such people valetudinarians (p. 17) is perhaps unfair.

The intrusion of speculative philosophy into medicine, vigorously attacked by the author of "Ancient Medicine", appears, if we may judge from the subsequent literature, never to have had much effect on actual medical practice. Every art, in addition to the practical theory that explains and reinforces it, has beyond this a speculative background of theory pure and simple. This speculation has a useful part to play, the classic example being Manson's guess that mosquitoes are connected with malaria, a guess that led to the discoveries of Ross. In the infancy of science it tended to encroach upon practical theory, so that the author of "Ancient Medicine" felt bound to protest. Greek thought, in fact, was over-rich in this intelligent guesswork, throwing out suggestion after suggestion in wild profusion. We moderns on the other hand are prone to undervalue it, although every now and then a Jeans or an Eddington inspires us with restrained and beautiful speculation. On the whole, however, we confine such thought to fiction. We should not like to read H. G. Wells's fascinating theories in a text-book.

On p. 28 of Prof. Farrington's lecture we read: "almost two thousand years after Aristotle . . . was explicitly formulated . . . the belief in the existence of definite bodies capable of being isolated . . . and recombined into new compounds". The latter half of this sentence would surely be a good description of the atomistic hypothesis of Democritus!

Even if these criticisms be justified, Prof. Farrington's lecture is of great value, and must certainly be taken into account by historians of Greek thought.

W. H. S. JONES.

THE GAS RESEARCH BOARD

THE Gas Research Board, which is supported by the Institution of Gas Engineers, the Society of British Gas Industries, and other bodies and individuals in the British gas industry, has recently issued its second report*. War-time conditions have prevented publication of some of the research done under its auspices and also the holding of the normal autumn research meeting.

The thirty-second report of the Refractory Materials Joint Committee*, which is also published, records, among other subjects, experiments on the materials used in the manufacture of firebacks for open coke fire-grates. Reference is made to the advantages in heating efficiency and performance of the use of the insulating refractory firebricks which have been so extensively developed in recent years.

Two reports, issued by the Gas Research Fellows for the year 1939–40 and 1941, deal with properties of Bunsen flames—in particular with flame ignition and propagation. There are two methods of measuring flame velocity: (*a*) the static method whereby propagation through a stationary explosive mixture is measured photographically; and (*b*) when the velocity is calculated from the form and size of the stationary inner cone of a Bunsen flame and the known rate of gas mixture fed to the burner. Hitherto results have shown great discordance, which has now been traced to the unjustified assumption that the inner 'cone' of a Bunsen flame is a true cone. It has now been shown that if the true area of the inner cone is measured and used in the calculation, then ignition velocities are obtained by this method which are independent of rate of mixture feed and burner size, depending only on working temperature and pressure. In other words, the ignition velocity so determined is a characteristic of the composition of the gas-air mixture. This should greatly facilitate the study of flame combustion.

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* (1) Communication G.R.B. No. 4. Pp. 16. (2) Communication G.R.B. No. 5. Pp. 92. (London: Gas Research Board, 1941.)

It is often overlooked that the inner cone of a Bunsen flame does not touch the burner, from which it is separated by a 'gap' or 'dead space' in which the mixture is preheated to the temperature at which inflammation occurs. It appears that the size of the 'dead space' determines the possibility of 'lighting back', for when the diameter of the burner is reduced to twice the 'dead space', then the flame cannot pass down the tube. The influence of size of tube and hole in stopping the travel of flame is well known and usually ascribed to the cooling, but it now appears to be essentially a characteristic of the gas.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk are open to the public*)

Tuesday, May 12

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m. —Dr. J. Alison Glover: "The School Medical Service in War-time".*

Illuminating Engineering Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. G. H. Wilson: "Street Lighting: Past, Present and Future".

Wednesday, May 13

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Miss Helen Masters: "The Post-War Home", 11: "Domestic Offices, Equipment and Maintenance".

Pharmaceutical Society of Great Britain (in the Small Hall of Friends House, Euston Road, London, N.W.1), at 2.30 p.m.—Dr. Philip Hamill: "Prescribing in War-time."

Institute of Metals (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. William Thomson Halcrow: "Water Power and its Application to the Production of Metals" (Thirty-second Annual May Lecture).

Friday, May 15

Royal Institution of Great Britain (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. C. Plummer, F.R.S.: "Galileo and the Springtime of Science".*

Sunday, May 17

Association of Scientific Workers (Southern Area) (in the Refectory, University College, Southampton, at 2.30 p.m. Conference on "Science for Victory" *

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Deputy Borough Electrical Engineer in the Electricity Undertaking of the Woolwich Metropolitan Borough Council—The Town Clerk, Town Hall, Woolwich, London, S.E.18 (May 15).

Principal of the Walker Technical College, Oakengates—The Secretary for Education, County Buildings, Shrewsbury (May 16).

Civil Engineering Assistant—The Clerk to the River Ouse (Yorks) Catchment Board, 7 Langcliffe Avenue, Harrogate (May 20).

Inspector of Agriculture to serve during his early years as Lecturer in the School of Agriculture near Khartoum—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (endorsed "Inspector of Agriculture") (May 25).

University Chair of Radiology (Therapeutic) tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (May 26).

Head of the Chemistry Department—The Secretary, Robert Gordon's Technical College, Aberdeen (May 30).

Lecturer in Biology (part-time)—The Principal, Bishop Otter College, Chichester.

Lecturer (woman) in Biology and Horticulture—The Principal, The Training College, Lincoln.

Lecturer in Geography (part-time) at the Brighton Municipal Training College—The Education Officer, 54 Old Steine, Brighton.

Assistant (male) to the Public Analyst—The Secretary, Health Department, Grey Friars, Leicester.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 15: The Molecular Weights of Rubber and related Materials, 3: A Correction of Part 2; 4: The Micellar Theory of the Structure of Rubber. By G. Gee. Pp. 8. (London: British Rubber Producers' Research Association.) [204

Other Countries

U.S. Department of the Interior: Geological Survey. Bulletin 890-B: Spirit Leveling in South Carolina, Part 2: Southern South Carolina, 1896-1938. Pp. ii+457-766+plates 1-2. 40 cents. Bulletin 900-D: Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma, Part 4: Townships 24 and 25 North, Ranges 10 and 11 East. By L. E. Kennedy, J. D. McClure, H. D. Jenkins and N. W. Bass. Pp. iv+131-172+plate 4. 35 cents. Bulletin 900-E: Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma, Part 5: Townships 26 and 27 North, Ranges 10 and 11 East. By L. E. Kennedy, W. E. Shamblin, Otto Leatherock and N. W. Bass. Pp. iv+173-208+plate 5. 40 cents. Bulletin 901: Clay Investigations in the South States, 1934-35. Reports by W. B. Lang, P. B. King, M. N. Bramlette, T. N. McVay, H. X. Bay and A. C. Munyan. Pp. x+346+8 plates. 1 dollar. Bulletin 907: Geology of the Alaska Railroad Region. By Stephen R. Capps. Pp. vi+202+9 plates. 1.25 dollars. Bulletin 913: Triangulation in Utah, 1871-1934. Pp. iv+170+1 plate. 20 cents. Bulletin 914: Microscopic Determination of the Ore Minerals. By M. N. Short. Second edition. Pp. viii+314+14 plates. 1 dollar. Bulletin 915-A: Geophysical Abstracts 96, January—March 1939. Compiled by W. Ayvazoglou. Pp. ii+48. 10 cents. Bulletin 915-B: Geophysical Abstracts 97, April—June 1939. Compiled by W. Ayvazoglou. Pp. ii+49-86. 10 cents. Bulletin 915-C: Geophysical Abstracts 98, July—September 1939. Compiled by W. Ayvazoglou. Pp. ii+87-132. 10 cents. Bulletin 916-D: Transit Traverse in Missouri, Part 4: Northwestern Missouri, 1911-37. Pp. xx+441-564+1 plate. 20 cents. Bulletin 916-E: Transit Traverse in Missouri, Part 5: Southwestern Missouri, 1900-37. Pp. xiv+565-732+1 plate. 25 cents. Bulletin 916-F: Transit Traverse in Missouri, Part 6: Northeastern Missouri, 1900-37. Pp. xiii+733-868+1 plate. 20 cents. Bulletin 916-G: Transit Traverse in Missouri, Part 7: Central Missouri, 1902-37. Pp. xiv+869-1024+1 plate. 25 cents. Bulletin 922-A: Quicksilver Deposits of the Bottle Creek District, Humboldt County, Nevada. A Preliminary Report by Ralph J. Roberts. (Strategic Minerals Investigations, 1940.) Pp. iii+29+plates 1-5. 35 cents. Bulletin 922-B: Quicksilver Deposits of the Mount Diablo District, Contra Costa County, California. By Clyde P. Ross. (Strategic Minerals Investigations, 1940.) Pp. iii+31-54+plates 6-8. 10 cents. Bulletin 922-C: Manganese Deposits in the Little Florida Mountains, Luna County, New Mexico. A Preliminary Report by S. G. Lasky. (Strategic Minerals Investigations, 1940.) Pp. iii+55-74+plates 9-11. 25 cents. Bulletin 922-D: Chromite Deposits of Grant County, Oregon. A Preliminary Report by T. P. Thayer. (Strategic Minerals Investigations, 1940.) Pp. iv+75-114+plates 12-20. 45 cents. Bulletin 922-E: Quicksilver Deposits at Buckskin Peak, National Mining District, Humboldt County, Nevada. A Preliminary Report by R. J. Roberts. (Strategic Minerals Investigations, 1940.) Pp. iii+115-134+plates 21-23. 15 cents. Bulletin 922-F: Tungsten Deposits of Boulder County, Colorado. By T. S. Lovering. (Strategic Minerals Investigations, 1940.) Pp. iii+135-156+plates 24-25. 20 cents. Bulletin 922-G: Manganese Deposits at Philipsburg, Granite County, Montana. A Preliminary Report by E. N. Goddard. (Strategic Minerals Investigations, 1940.) Pp. iv+157-204 +plates 26-34. 40 cents. Bulletin 922-H: Tungsten Deposits of the Atolia District, San Bernardino and Kern Counties, California. By Dwight M. Lemmon and John V. N. Dorr, 2*d*. (Strategic Minerals Investigations, 1940.) Pp. iv+205-246+plates 35-37. 25 cents. Bulletin 922-I: Antimony Deposits of a part of the Yellow Pine District, Valley County, Idaho. A Preliminary Report by Donald E. White. (Strategic Minerals Investigations, 1940.) Pp. iii+247-280+ plates 38-39. 30 cents. Bulletin 922-K: Antimony Deposits of the Wildrose Canyon Area, Inyo County, California. By Donald E. White. (Strategic Minerals Investigations, 1940.) Pp. iii+307-326+plates 45-46. 25 cents. Bulletin 922-M: Tin Deposits of the Black Range, Catron and Sierra Counties, New Mexico. A Preliminary Report by Carl Fries, Jr. (Strategic Minerals Investigations, 1940.) Pp. iii+355-370+plates 54-62. 50 cents. (Washington, D.C.: Government Printing Office.) [144

U.S. Department of Agriculture. Farmers' Bulletin No. 1893: Control of Grape Diseases and Insects in Eastern United States. By J. B. Demaree and G. A. Runner. Pp. ii+28. (Washington, D.C.: Government Printing Office.) 10 cents. [154

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology, No. 10: Items 5135-5279; July to December 1941. By Ernest A. Hodgson. Pp. 157-188. (Ottawa: King's Printer.) [204

Transactions of the San Diego Society of Natural History. Vol. 9, No. 32: A Vertebrate Faunal Survey of the Organ Pipe Cactus National Monument, Arizona. By Laurence M. Huey. Pp. 353-376. Vol. 9, No. 33: Notes on some Mexican and Californian Birds, with Descriptions of Six Undescribed Races. By A. J. van Rossum. Pp. 377-384. (San Diego, Calif.: San Diego Society of Natural History.) [204

The South African Journal of Science. Vol. 38: Being the Report of the Thirty-ninth Annual Meeting of the South African Association for the Advancement of Science, Johannesburg, 1941, 30th June and 1st July. Pp. xx+399. (Johannesburg: South African Association for the Advancement of Science.) 30*s*. net. [204

Department of Science and Agriculture, Jamaica. Report for the Year ending 31st March 1941. Pp. 6. (Kingston: Government Printing Office.) [224

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SCIENTIFIC UTILIZATION OF MAN-POWER

THE White Paper on machinery for the joint planning of the War which the Prime Minister has now wisely issued does not add greatly to our knowledge, although it puts into precise terms much information which has hitherto been given either informally or piecemeal. It fills a gap, and the discussion on the adequacy of our machinery can now proceed on a sounder basis. That discussion and criticism have been carried over from Parliament into the Press, notably in the *Economist* and in *The Times*. In the latter Sir Edward Grigg's able article, which has drawn comment from Lord Hankey, Lord Chatfield, Lord Swinton, Lord Strabolgi, Prof. A. V. Hill and others, advocates the introduction of a single chief of a Combined General Staff standing outside and above the three Chiefs of Staff and presenting one opinion to the Premier and the War Cabinet. The question of the best system is a practical one and not all the critics agree. Moreover, counsel is sometimes confused, and the *Economist* and Prof. A. V. Hill seem to have kept closest to the heart of the matter. The *Economist* insists that the General Staff that is required must be one trained in the technique of co-operation of all three Services but belonging to none, so that the difficulties sometimes advanced as to whether the navy is to direct military or air force operations or *vice versa* do not arise. The recent appointment of Vice-Admiral Lord Louis Mountbatten as chief of Combined Operations is an indication, however, that we are moving further than the White Paper indicates in the direction of the integration on which Prof. Hill lays his stress.

What is required, Prof. Hill holds, is an integrated war staff, a high command, designed for the purpose of planning the war as a whole, not further additions to existing machinery. Already, as the White Paper points out, to ensure that operational planning and production planning are even more closely combined, there has recently been created the Joint War Production Staff. Prof. Hill argues that a complete war staff must include several elements not present in a mere combination of Service staffs. First, a chief of technical staff, guiding research, design and development with a view to operational needs and keeping the war staff informed on technical matters; secondly, a director of operational research responsible for the scientific analysis of the results of past operations and the critical study of current operational plans and methods; third, a joint technical liaison and intelligence officer for civil defence, who could help to devise offensive and defensive policy in relation to the actual effects of bombing. The neglect of these technical elements has, in Prof. Hill's view, had much to do with our failures and disasters.

Mr. Lyttelton's announcement of the formation of a production panel promises to remedy what has long been lacking—the use of technical men of authority to report on the weak places in production, give advice on the spot, or present findings to the highest authority. Field-Marshal Lord Milne's criticism of the joint war production staff is based on the staffing of its technical personnel from the Supply Departments instead of from the Service Ministries. He points out that chief technical officers of Supply Departments are not in the position to co-ordinate operational planning, because they are solely concerned with giving effect to a policy already laid down by the Service Ministry.

That criticism is valid up to a point, but unfortunately it is equally true that Service personnel have only too often proved incompetent to assess the significance for operational planning of technical developments. The basic charge against our operational planning is, in fact, that it has been too limited by Service traditions and experience, and too remote from the new possibilities of operations that technical advance has put at its disposal. The integration of the three Services in regard to a grand war strategy is not more important than the integration with them of the technical side to which Prof. Hill has directed attention.

The nearer we approach to our maximum effort, the severer are the limitations on our resources of materials or man-power, the more important are these questions of organization, co-ordination and integration at the centre. Improvisation can no longer be tolerated. Policy must be concerted and based on a view of the problem and situation as a whole, not of bits and pieces. Mr. Lyttelton has given clear evidence in his statement that he sees his problem as a whole, and the new White Paper provides at least some evidence that the Government is moving to the evolution of a common war strategy based on a corresponding vision and served by the appropriate instruments for its execution—though the pace may seem uncomfortably slow to some of the critics.

It is clear that the volume of criticism both within and without Parliament is having an effect in clearing away departmentalism and forging closer links and fuller integration between the three Services as a single fighting unit animated by the same spirit and the same conception of a common task. That integration, however, needs to be carried further and to embrace the production side of our war effort also. The beginnings of this were indicated in Mr. Lyttelton's first statement as minister, and its importance is further stressed in the latest of the long and valuable papers on war administration which have come from the Select Committee on National Expenditure. One of these, the seventh of the present session, while dealing mainly with matter falling within the sphere of the Ministry of Labour, raises the fundamental question of the distribution of man-power between industry and the Fighting Services.

This is the basic question of man-power policy. Without an answer to it we cannot judge how near Great Britain is to ensuring that every person in the community is contributing the best of which he or she is capable, nor can we make plans to that end. None of the several committees on man-power has as yet been charged with the task of finding out whether the proposed size and equipment of the armed forces represents the maximum military effort which the country can make. Each was subject to the precedent condition that the numbers to be taken for the Forces had already been determined by higher authority. The really fundamental question, namely, the distribution between the Forces and industry which will enable the national man-power, having regard to the ever-changing needs of the war, to make the maximum contribution to the combined striking force of the United Nations, has never been put to them.

The Select Committee considers that it is essential that there should be an independent permanent body to provide at least the materials for an answer to this question—to consider and calculate the effects of any particular allocation of man-power between industry and the Services. Its principal task should be to estimate the best allocation of man-power between industry and the Fighting Services, and as part of that task it should also have the duty of examining the allocation of man-power between the broad categories of industry. The principal recommendation of the seventh report is the establishment of a permanent committee for this purpose, independent of departments and reporting direct to the War Cabinet.

A body of this character would go far to supply the breadth of conception and to stimulate the firmness of execution which are necessary for the development of the maximum military strength. Had it been in existence, for example, opposition to the fuel rationing scheme based on the pressure for release of miners for the forces could scarcely have been engendered. Moreover, there would be less danger that the need for expansion of output, here or in the munition industries, might be met by further recruitment of labour when more careful employment of the workers already engaged would have achieved the same end. The mere meeting of employers' demands for labour is not proof that the country's capacity is fully utilized, for those demands are not necessarily a measure of the real needs of the country.

What emerges from the rest of this long and searching report is the crucial importance of the human factor, as is also stressed in the report on the human side of war production, recently issued by Mass Observation (Charge No. 3. An Inquiry into British War Production. Part 1. People in Production). This report deals with the efficient use of the available men and women, and it fully corroborates the detailed analysis and recommendations of the Select Committee. Efficient production and the exertion of maximum effort are the outcome not only of wise direction and concerted policy at the centre but also of assiduous and unremitting attention to detail everywhere, above all in those matters which affect the welfare and morale of the industrial population. In this connexion the Select Committee holds that the general responsibility for welfare should rest with the Ministry of Labour, which is relatively independent of the factories and is already the principal department concerned with the well-being of employees. The reconstituted regional boards should undertake the responsibility for supervising the efficient utilization of labour, labour supply in this way being treated as an integral part of the problem of production.

The forty recommendations of this report of the Select Committee are, in fact, largely directed against departmentalism and neglect to implement provisions already made. Emphasis is laid, for example, on stricter attention to securing that officials responsible for dealing with absenteeism, etc., exercise their powers fully under the Essential Work Order, as well as on the importance of disseminating technical knowledge, such as new methods of 'de-skilling' which bring about the more economical use of labour. Greater efforts to persuade managements to make arrangements for the part-time employment of women are recommended, and there is a pointed warning that it may be necessary to reconsider the exemption from compulsion of mobile women merely on the grounds that their husbands are with the Forces. How much this is a matter of organization and initiative is well brought out in a broadsheet of P E P (Political and Economic Planning) devoted to part-time employment.

Apart from welfare matters, there are pertinent comments on concentration. The policy of concentration, the report points out, will only have achieved its purpose if the total output from the industries concerned has been reduced to the minimum required to meet the needs of the Services, the civil population, and the export trade, with the minimum of labour and other resources, and if the labour and other resources released are actually transferred to essential work. Notably in the cotton trade these conditions do not appear to have been satisfied, and the Committee recommends emphatically that in determining the degree to which an industry should be concentrated the criterion should be the level of output required to meet war needs: The criterion for determining which establishments should be retained should be efficiency, and nucleus certificates should only be granted to the most efficient firms. Statistic of output and employment should be carefully examined and any unsatisfactory increase in the output per worker investigated. Closer check should be kept on the movements of workers released as a result of concentration schemes and, in particular, great care taken to make full use of persons in supervisory grades who are released as a result of concentration is recommended.

The importance of the distributive trades as a possible source of labour is once again emphasized by the Committee, and the observations on training include the recommendation that periodic investigations should be made to discover whether trainees are being properly placed and for the maintenance of contact between training centres and their more promising trainees to secure that, if they prove suitable, the opportunity for up-grading is not wasted. The cumulative effect of these detailed recommendations should be considerable, and if implemented they should go far to eliminate many sources of wasted man-power which, even if small in themselves, in the aggregate are increasingly serious in their effect upon production.

The eighth report of the Select Committee is concerned more specifically with the organization of production, and with the relation of production to strategy. It is indeed a lucid annotation of Mr. Lyttelton's statement on his functions as Minister of Production which was made between the drafting and the publication of the report. As in the report on labour, the Committee comments on the present improvisation and the absence of sufficiently prescient and progressive planning. The main need appears to be a better use of the available forces rather than an increase in their number. While recognizing the marked improvement of the last twelve months, the Committee is convinced that the Government, industrial management and the manual workers can and must do better.

It is for the Government to give the call and the opportunity to the other two main agencies to do their best, and for this reason the report gives most of its attention to Government direction and organization. On particular points which throw light on defects in organization, it notes the insufficient attention paid to the importance of greater specialization and to distributing contracts so that each manufacturer can concentrate on a limited number of types of product suitable to him, thus providing a sufficient run on each type to secure the most economical mass-production methods. Not enough attention has been paid to directing contracts, labour and materials to the most efficient factories where the man-hours on any job are lowest, or to the proper adjustment of work and capacity in the vast field of sub-contracts. Non-essential industries are still not properly regulated, and once again the importance of good personnel management and of proper arrangements for housing, transport and general welfare is reiterated.

On the general question of organization, the Committee reaches two main conclusions. First, there must be a supra-departmental authority to plan the programme, and secondly, the planning must be informed, based on an accurate appreciation of existing factors, and adequate forethought as to probable future developments. The evidence suggests that the programme for manufacture as transmitted to industry shows signs of inadequate foresight and sureness of decision. Accordingly it should have been possible for the Services to do better than they have in getting the right kind of weapons at the right time.

On the first point the Committee is satisfied that the new Minister of Production will be in a position to ensure unified direction. On the second, it stresses the vital importance of the Minister having at his disposal an adequately staffed intelligence and programmes organization, equipped with the means for collecting and interpreting all relevant data affecting the requirements of the Fighting Services, raw materials, supplies, manufacturing capacity and man-power. On this recommendation follows the further one that the Government should examine as a matter of extreme urgency what steps can be taken to improve the existing arrangements for ensuring that Fighting Services requirements are formulated with precision and so far as possible in advance, and that these are worked out without delay in terms of 'production jobs' and introduced into the production programme with adequate notice to the manufacturers concerned.

Passing from the vital task of relating, or rather integrating, the planning of production with the planning of operations and strategy, the Committee insists upon the necessity for a clear appreciation of the proper functions of the various agencies concerned with the execution of the national programme. Strong arguments are advanced for further decentralization, particularly in arranging and supervising the details of production. Great reliance should be placed on the regional organization of the supply departments, and revision of the present constitution and powers of the regional boards is recommended. Simultaneously, the Committee directs attention to the importance of keeping regional officers fully informed by their departments on all matters which may have a bearing on their duties, as well as to the necessity of a clear chain of responsibility if there is to be effective co-ordination of departmental activities at regional level.

In all this the report is recalling established principles of scientific management which have been neglected, with the usual results. The Committee also advocates measures for devolving responsibility on industrial organizations and for fitting the smaller factories accurately into the national plan. Stress is once more laid on the importance of supervision of execution, and it is recommended that departments should take more active steps to ensure both that good methods developed in one factory are made known to others and that the most efficient works are brought up to the fullest possible employment in priority over those that are less efficient. Similarly, in keeping with Mr. Lyttelton's own statement, the report recommends that all possible steps should be taken to enable workers in factories to have a true understanding of the war position and of the conditions affecting the work in which they are engaged, as well as to encourage the formation of joint production consultative and advisory committees.

These two reports are heartening documents. Among the best of the long series that the Select Committee has given us, they put a searchlight on many weaknesses in the planning, organization and execution of our war effort, accompanied by recognition of the immense effort that has already been made. It is clear that a number of their recommendations have been anticipated, and it may well be possible that further adjustments as yet not made known have brought planning and administration at the centre even more into line with the scientific principles so clearly enunciated in these reports. The emphasis which is simultaneously placed on the need for decentralization, for concentrating in the regional organization sufficient authority to act with speed and authority comes, however, nearer to us all. It should bring into the production field the basic requirement of a subordinate officer in all the Fighting Services, namely, a thorough understanding of his superior's stragetical plan as it affects his duties, and a reliance on his own initiative in its tactical application. Given subordinates in production who can meet these requirements, we should go far to ensure that maximum co-operation and response from the human element upon which in the end both efficient production and final victory depend.' Scientific workers cannot but welcome the evidence that further weight is being given to the technical factor in production and strategy, that the production genera staff is itself becoming competent to contribute t the formation of strategy, and that a scientific min and a scientific outlook are increasingly making themselves felt through the whole field of defence an offence, with the firm elimination of inefficiency o slackness wherever met, and steady, persisten improvement of methods as well as output an weapons. The new Appointments Department jus established by the Minister of Labour to take ove the Central Register and the Supplementary Registe implementing the reform promised last December is only the latest evidence of this new determinatio to make full use of technical and professional qualifications and to distribute ability on a more scientifi basis.

THE ANALYTICAL FOUNDATIONS OF CELESTIAL MECHANICS

The Analytical Foundations of Celestial Mechanics
By Aurel Wintner. (Princeton Mathematical Series No. 5.) Pp. xii+448. (Princeton, N.J.: Princeto University Press; London: Oxford Universit Press, 1941.) 36*s*. net.

FROM the beginning of civilization one need mus make itself felt, namely, for some form o calendar. In turn, this gives rise to the primitiv study of astronomy, involving some knowledge o the sun and the moon. When the planets are adde in the next stage, the astronomer needs an ephemeri or almanac; the modern Nautical Almanac, with it perfection within narrow limits, is the final outcome There have been many stages on the road, and som apparent interruptions. But the urge has alway been the same, essentially a practical one.

For the construction of the necessary tables c almanac some form of theory is required. Such theory need not be true in order to have value, an in fact it may be grossly in error. Thus the firs theory of any practical importance was the Ptolemai which assumed the earth to be fixed. On this wer based the Alfonsine tables, completed in the middl of the thirteenth century. The results may seem crud but with minor adjustments it is well to remembe that, surviving the transition from manuscript t printing, these tables served all practical need however imperfectly, for three centuries; it remain to be seen whether any modern tables will las nearly as long. Then came the Copernican theor with a different frame of reference, but the result when expressed in the form of tables were no bette if indeed they were not worse. Next came th Rudolphine tables, based on Keplerian theory. Her a great advance ought to have been clearly visibl but it escaped the appreciation of all but one remarkable man, Jeremiah Horrocks. However, this theor came at last into the hands of Newton, and from this point the problem assumed its modern form.

In this shape the Nautical Almanac, or similar ephemeris, represents the practical solution of a set of differential equations. These involve a number of numerical constants, the masses of the sun, planets and satellites, and their positions and motions at some given epoch, or equivalent information; the gathering of an adequate knowledge of such data has been a slow process of approximation. After Newton the early steps were taken by Clairaut and Euler. Afterwards we are chiefly indebted to Laplace, Le Verrier and Newcomb for planetary theory, to Hansen, Delaunay and E. W. Brown for lunar theory. These in their generation have all done their work well, so that to-day the approach to perfection in the solution of the two main types of gravitational problem may be considered quite satisfactory. For the time being, the working astronomer has been provided with the highway which he needs.

The construction of this highway means, as stated, the practical solution of a set of differential equations. In the process the astronomers, some of whom have been named, have taken what help the mathematicians of their day provided, but for the most part have evolved their own methods and, trusting to their own intuition, have had to take risks which the more rigorous mathematician might afterwards justify or might not. Thus in the course of providing for the main astronomical traffic, they have left a whole field of research open to the mathematician and one which if not inexhaustible does not show signs of being exhausted very rapidly. One question concerns the very nature of a system of differential equations, about which there is (p. 144) "Poincaré's dictum, according to which a system is neither integrable, nor non-integrable, but more or less integrable". Similarly, there is the problem of stability, which can be defined in several independent ways and must defy final solution until such definitions can be shown to be exhaustive.

There are, therefore, two different kinds of book which can be written about celestial mechanics. The one will treat mainly of the methods, usually approximate but practicable, which the theoretical astronomer uses with highly successful though limited effect. The other deals with the corresponding mathematical theory, the existence theorems needed for rigour, the provision of new and more powerful methods, and the discussion and development of points arising in the course of the severely practical problem of prediction. To the latter class the present work belongs, and it makes its appeal to the ambitious student who is not to be deterred by the technique of modern mathematics. Happily, the author is familiar with both sides of the subject, and has produced a book which, so far from being arid, is exceedingly interesting even to those who are not prepared to assimilate all its abstruse details. This is helped by unusually ample references to the historical development, ending in a final section devoted to this aspect. The value of this attention to the historical past would have been enhanced by the addition of a name index.

The course of development may be illustrated by reference to the lunar problem. Brown's treatment of this thorny subject, which gave even Newton a headache, was initiated by G. W. Hill. This is based on a periodic solution of an idealized form of the problem of three bodies, and no longer starts from a solution of the problem of two bodies. Hence arose the restricted problem, in which two bodies describe relatively circular orbits while the third is massless. The periodic motion of such a body, attracted but not disturbing, has been considered by Thiele, G. H. Darwin and with the greatest numerical detail by E. Strömgren. As a theoretical problem it has been considered by Poincaré and others. Thus, starting with transformation theory and dynamical systems, the book gravitates towards the restricted problem for which the ground has been prepared in earlier chapters. To the advanced student of celestial mechanics a knowledge of the analytical foundations is clearly indispensable, and Dr. Wintner's book can be recommended to his attention and careful study.

H. C. PLUMMER.

TENSOR CALCULUS

An Introduction to Differential Geometry with Use of the Tensor Calculus

By Prof. Luther Pfahler Eisenhart. (Princeton Mathematical Series, 3.) Pp. x+304. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1940.) 21*s.* 6*d.* net.

THIS book gives a thorough introductory study of the properties of ordinary points in the differential geometry of curves and surfaces in 3-space. Chapter 1 gives an account of twisted curves, Chapter 2 describes the tensor calculus. In Chapter 3 this calculus is applied to investigate the intrinsic geometry of a surface, that is to say, those properties which depend on the first fundamental form. Chapter 4 develops those properties which derive also from the second fundamental form and therefore characterize the surface as viewed from the enveloping space.

On account of the expository character of this text-book, it is Chapter 2 which gives rise to some reflections. In introducing the notion of a tensor it has become the custom, which is also adopted in this book, to emphasize heavily the transformation aspect and to leave the student very vague as to the essential simplicity of the tensor idea. There is, however, an easier and perhaps more logical approach by means of the indefinite multiplication of ordinary vectors. If $\mathbf{a}$, $\mathbf{b}$, $\mathbf{c}$ are vectors (tensors of the first order) and a semi-colon denotes indefinite multiplication, ordered combinations such as $\mathbf{a}\,;\,\mathbf{b}$ or $\mathbf{a}\,;\,\mathbf{b}\,;\,\mathbf{c}$ or the sums of like combinations are tensors of the second and third orders respectively. Contraction then consists of replacing indefinite multiplication by scalar multiplication. Thus the tensor $\mathbf{a}\,;\,\mathbf{b}\,;\,\mathbf{c}$ can be contracted for example to $(\mathbf{ab})\mathbf{c}$ by taking the scalar product of the first pair of vectors. In applying the tensor calculus to differential geometry, it often becomes necessary at some stage to use a co-ordinate system, say, x^r. We can then introduce at any point P a local system of vectors, or a basis, $\mathbf{e}_r$, such that the vector PQ, where Q is an adjacent point x^r+dx^r, is $d\mathbf{s} = \mathbf{e}_r dx^r$, and at the same time we define the reciprocal basis $\mathbf{e}^r$ by the relation $\mathbf{e}_r\mathbf{e}^s = \delta_r$ in terms of Kronecker's deltas. The fundamental quadratic form is then simply $d\mathbf{s}d\mathbf{s} = \mathbf{e}_r\mathbf{e}_s\, dx^r dx^s$, which shows that the number usually called g_{rs} is a scalar product of two vectors of the basis. Any vector at P can be expressed either in terms of the basis or in terms of the reciprocal basis. Thus if $\mathbf{a} = a_r\mathbf{e}_r = a_s\mathbf{e}^s$ and

$\boldsymbol{b} = b^r\boldsymbol{e}_r = b_s\boldsymbol{e}^s$, the tensor $T = (\boldsymbol{a}\,;\,\boldsymbol{b})$ can be expressed in the three forms

$$T = a^r b^s(\boldsymbol{e}_r\,;\,\boldsymbol{e}_s) = a^r b_s(\boldsymbol{e}_r\,;\,\boldsymbol{e}^s) = a_r b_s(\boldsymbol{e}^r\,;\,\boldsymbol{e}^s),$$

which show the so-called contravariant, mixed and covariant indices, and the relative unimportance of these adjectives.

To define the Christoffel symbol of the second kind (the first kind has no essential applications) we write as definition

$$\frac{\partial \boldsymbol{e}_r}{\partial x^s} = \frac{\partial^2 \boldsymbol{s}}{\partial x^s \partial x^r} = \begin{Bmatrix} t \\ rs \end{Bmatrix} \boldsymbol{e}_t, \text{ whence } \frac{\partial \boldsymbol{e}^r}{\partial x^s} = -\begin{Bmatrix} r \\ ts \end{Bmatrix} \boldsymbol{e}^t.$$

These results together with the vector differentiation operator $\nabla = \boldsymbol{e}^i\partial/\partial x^i$ contain the whole manipulation of differentiation. For example, we have the tensor

$$\nabla\,;\,\boldsymbol{a} = \boldsymbol{e}^i\frac{\partial}{\partial x^i}\,;\,a_r\boldsymbol{e}^r = (\boldsymbol{e}^i\,;\,\boldsymbol{e}^r)\left[\frac{\partial a_r}{\partial x^i} - a_s\begin{Bmatrix} s \\ ir \end{Bmatrix}\right],$$

which gives the covariant derivative and shows that it is a tensor.

The considerations thus briefly indicated are of general application to n-space and to tensors of any order. Moreover, they render obvious the proof of, and the connexion between, such theorems as 16·6 and 17·6, which in spite of their dissimilar enunciations are merely statements regarding the basis and its reciprocal. Similarly, the Frenet formulæ in general co-ordinates follow at once from their ordinary vector form.

The book is beautifully printed and has many excellent diagrams and illustrations. It has also another claim to the student's attention, namely, the large number of exercises, many of which contain important theorems. There are a bibliography of works to which the author refers and a useful index.

L. M. Milne-Thomson.

FORENSIC SCIENCE

Science for the Prosecution

By Dr. Julius Grant. Pp. vii+302+25 pl. (London: Chapman and Hall, Ltd., 1941.) 15*s*. net.

Forensic science, or the application of scientific investigation to the purposes of the law and the administration of justice, is an outcome of the older subject of forensic medicine or medical jurisprudence. Whereas forensic medicine deals primarily with offences against the person, forensic science covers a somewhat wider field and includes the investigation of offences against property.

It is only within comparatively recent years that the latter subject has assumed an important position in the investigation of criminal offences. The importance of forensic medicine, on the other hand, was recognized in Great Britain so long ago as the end of the eighteenth century, when voluntary lectures were given on it at Edinburgh, and were followed by the establishment by the Crown of a chair of forensic medicine in 1807 at the University of Edinburgh. This was the first of its kind in any English-speaking community. Although this subject has now become an integral part of the medical curriculum, and each medical school now has its lectureship on the subject, there is only one other full-time chair complete with its department in Great Britain, namely, that of the University of Glasgow.

Forensic science has gradually evolved from the older subject, and in connexion with this may be mentioned the names of Lombroso of Turin, Locard of Lyons and Söderman of Stockholm. Institutions for the study of forensic science are (or were) in active operation in Paris, Lyons and Lille, that o Paris being founded in 1912. In Great Britain, the Metropolitan Police Laboratory was established in 1935, and this was followed by the establishment by the Home Office of Regional Forensic Science Laboratories at Nottingham, Cardiff, Birmingham, Preston and Wakefield. Although these laboratories are there to assist the police, the reports issued from them are naturally entirely independent as to whether they favour the prosecution or the defence, and they may be used therefore afterwards in a court of justice by either side.

Dr. Julius Grant has written a most interesting and valuable book on the methods used in forensic science. As he says in his preface, he has adopted a semi-popular treatment of the subject, the book being primarily intended for the lay reader and to introduce the subject to the lawyer. One feels that although it has this general appeal, it would be better for the reader to have some knowledge and interest in science before he could fully understand and appreciate its contents. It covers a wide field embracing the work of the physicist, the chemist the biologist, the pathologist and the psychiatrist In other words, there are various chapters on optica methods, including ultra-violet and infra-red rays X-rays, spectroscopy, the microscope and the camera, chemical methods, blood-group tests and serum analysis, and lastly psychology and crime. Of all the methods discussed, probably the most important and the one most frequently used is that of microscopy. This is fully admitted by the author especially when the microscope is used in conjunction with the camera; but even the camera may not always be necessary.

Methods of examination by ultra-violet and infra-red rays are extensively used in this type of work and the chapters dealing with these give a very clear outline of their importance and use. Although X-rays have not been used to any great extent up to the present, the most striking results have been obtained from the examination of oil paintings of the 'Old Masters'. The pioneer work of Prof. A. P Laurie must always be remembered with regard to this type of investigation.

The chapter on chemical methods covers a wide field, from the detection of poisons to the decipherment of charred documents, the latter having assumed a certain degree of importance during the past two years. The blood-alcohol test is also dealt with, and one is glad to see the very fair opinion given of the value of the test.

The general reader will also obtain a good knowledge of the blood-grouping tests with regard to blood stains and paternity cases, and finally there is an interesting discussion on psychology and crime It is doubtful whether such methods as those described in the use of the 'lie detector' would ever be tolerated in Great Britain.

In conclusion, it must be said that this book contains an amount of interesting information, interestingly set forth within a comparatively limited space, and can be recommended not only to those for whom it was apparently written, but also to those who are actively engaged in forensic laboratory work. The book is well illustrated with plates and diagrams.

J. Davidson.

COLOURS IN FOOD

THE practice, now widespread, of adding colouring matter to foods has not always found favour with the authorities, as is instanced by the heavy penalty of £500, imposed by an Act of 1816, for selling colouring agents for the darkening of beer. This was mentioned by Mr. D. J. T. Bagnall, city analyst for Hull, in his paper opening a discussion on "Colours in Food" held on April 13*. Foods are coloured by the addition of (1) metallic salts such as copper sulphate, although the use of copper salts is now prohibited in Great Britain; (2) natural colouring matters such as cochineal, saffron or annatto; (3) synthetic dyes, the principal method now in use. Attractive colours may also be imparted to certain foods by such processes as smoking or pickling.

The principal reasons for colouring food are to replace colour lost in processing or to imitate an article of superior quality. The process of canning entails partial loss of the natural colouring of the food, and this deficiency in tinned goods is frequently made good by the addition of artificial dyes. The need for this artificial colouring is lessened if the fruit or vegetables are freshly gathered and carefully processed, when the loss of colour is reduced to a minimum. The other motive for colouring foods, namely, to imply superior quality, is wholly reprehensible, according to Mr. Bagnall, who suggested that to colour cakes yellow to imply the presence of eggs is as serious an offence as to state on the label "Made with eggs" when in fact no eggs are present. Yellow colouring matters are added to butter and to cakes to suggest richness of quality. Chocolate cakes and chocolate biscuits are often dyed a deep brown colour to suggest the presence of cocoa, of which the actual amount may be so small that the addition of artificial essence is necessary to impart a chocolate flavour. Food dyes are sold under such poetic descriptions as 'egg yellow', 'gooseberry green', 'pea green', 'kipper brown', 'spinach green', and 'brawn pink'. Their mission is obvious from their names! A "perfect substitute for eggs" recently examined in Hull consisted of water (96·3 per cent), oil (0·5 per cent), sodium bicarbonate (1·0 per cent), cellulose gum (2·2 per cent) and a yellow dye. Without the dye this sticky liquid would have deceived no one. In the opinion of Mr. Bagnall the addition of colouring matter to foods of lower quality in order to render them more attractive is permissible only if the purchaser is notified of the lower quality and if the presence of the added colouring matter is declared.

Great Britain is the only leading country which has not a legal schedule of permitted colours. Any colouring matter may be added to food, provided it is not injurious to health, except compounds of antimony, arsenic, cadmium, copper, mercury, lead and zinc. Gamboge, picric acid, victoria yellow, Manchester yellow, aurantia and aurine are also prohibited. Other countries, including the United States, France, Canada, Australia, New Zealand, Italy, Spain, Sweden and Denmark have lists of permissible colours. Which of these two systems is to be preferred? Injuriousness to health is difficult to prove, and the effect of a dye on test animals may not be the same as on the human organism. The proportion of added colour in the food is so small that the dye could scarcely be harmful unless highly toxic, but this argument ignores the possible cumulative effects of frequent small doses. Mr. Bagnall is inclined to the view that only specified dyes proved to be non-injurious to health should be permitted, and that official standards of purity should be set up and enforced.

In the discussion which followed this paper it was suggested that Mr. Bagnall had over-emphasized the tendency to use food colours for purposes of deception. Delicate tinting of an article of food often made it more acceptable to the public, who demanded such colouring. Artificial colouring serves to compensate for the unavoidable deterioration of colour which often occurs with time and also to standardize the products.

Prof. J. W. Cook dealt with biological properties of dyes, with particular reference to those used for colouring foods. Synthetic colouring matters have long been known to have various kinds of biological activity. The staining of organisms by trypan blue and trypan red played an important part in the early development of chemotherapy, and the antiseptic action of such dyes as gentian violet, methylene blue, brilliant green and acriflavine has been much utilized. The earliest sulphonamide drugs were azo dyes (prontosil is a sulphamido derivative of chrysoidine, which has been used as a food dye). Dyes also find application in diagnostic tests. With these medicinal dyes it is scarcely surprising that their pharmacology has been much investigated. In the case of dyes used for colouring food the situation seems less satisfactory in this respect.

In a report published by the Ministry of Health in 1924 it was stated that more than ninety different dyes were supplied for colouring food in Great Britain. The actual number in common use appears to be about twenty-five, and of these the following seven are used in the largest amounts: Tartrazine, Ponceau *RS* or *2R*, Orange I or *IS*, Orange II or *GS*, Amaranth *AS*, Erythrosine *AS*, Rhodamine *B* or Rose *BS*. The first six of these are included in the list of food colours permitted in the United States. Four of them are included in a list of thirty-six synthetic dyes which are stated in Martindale's "Extra Pharmacopœia" to be harmless for colouring foods. Recent original literature contains comparatively little reference to the biological properties of food-colouring matters. Facts are accumulating, however, which suggest that the time has come when current practice and the existing regulations relating to this matter should be reviewed.

The causes of dermatitis associated with substances used for dyeing fur and hair have been much studied by H. E. Cox[1], who concluded that in a large proportion of cases the agent primarily responsible is *p*-phenylene diamine. This undergoes atmospheric oxidation to quinone di-imine, which is a powerful irritant. In this connexion it may be remarked that *o*-aminoazotoluene, which is stated to have been used as a food dye, is metabolized by rabbits to the diacetyl derivative of *p*-toluylenediamine[2].

Baer[3], in 1934, recorded a case of dermatitis which was attributed to a green synthetic colouring matter present in salads. The symptoms included an erythematous eruption on the neck, shoulders and arm. This suggests a photodynamic action, but it is stated that the eruption occurred on covered areas of skin as well as on uncovered areas. It is now recognized that many fluorescent dyes, introduced into the body, may lead to lesions of the skin on exposure to light, due to photo-sensitized oxidation of protein or amino acid[4]. This possibility should be borne in mind in connexion with the use of fluorescent dyes to colour food.

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* Summary of contributions to a discussion held in Leeds on April 13 at a joint meeting of the Yorkshire Section and the Food Group of the Society of Chemical Industry.

Two cases of dermatitis due to handling artificially coloured citrus fruits were reported in 1937[5]. The principal dye used for this is Yellow *OB* (*o*-toluene-azo-β-naphthylamine). In these and similar cases constant and repeated exposure to the dye probably produced hypersensitivity. Toxicity experiments carried out by Climenko[6] with *o*-toluene-azo-β-naphthol, an oil-soluble dye used also for colouring the skin of citrus fruits, showed that its acute toxicity is very low. The maximum dose after which recovery took place was 20 gm. per kilogram of body weight. No serious adverse effects resulted from daily administration for six months of doses up to 100 mgm. per kilogram of body weight. Many medicinal dyes are far more toxic than this. In cases of acute toxicity the dye often appears in the urine, and the liver, kidneys and other organs are stained with the dye. These organs also show pathological changes. It is of interest that Huggett and Rowe[7] have shown that many azo dyes, particularly those which are prepared from tetrazotized diamines and aminonaphthol sulphonic acids, are effective inhibitors of blood clotting.

Malignant tumours of the liver may be produced in rats and mice by administration of large doses of two azo dyes which have been stated to be in use as food-colouring matters. This was shown by Yoshida[8] in the case of *o*-aminoazo-toluene and by Kinosita[9] in the case of *p*-dimethylaminoazobenzene ('butter yellow'). Their observations have been amply confirmed and although it is believed that these dyes are not now used for colouring food their use should be prohibited. Similar pathological changes in the liver are induced in mice by 2 : 2′-azonaphthalene[10]. These circumstances led to tests being carried out with food dyes having structural resemblance to these, with the co-operation of Dr. J. J. Fox, who supplied valuable information as to the dyes in most common use and procured samples of them. Six azo dyes were selected for test, namely, Ponceau *RS*, Orange *IS*, Naphthalene Orange *GS*, Naphthalene Fast Orange 2*GS*, Amaranth *AS* and Metanil Yellow *YKS*. Mice were fed on brown bread soaked in aqueous solutions of the dyes so that each mouse received 15–20 mgm. per week. This would correspond with about 60 gm. for a man. The experiments were of adequate duration, but no tumours were obtained[10].

Five of the six dyes used in these tests are water-soluble sulphonates and hence would be rapidly excreted. Further tests were therefore carried out with Yellow *AB* and Yellow *OB*[11]. These two oil-soluble azo colours do not appear to be used in Great Britain, but are in common use in the United States. The dyes were administered to mice by feeding, by application to the skin, and by subcutaneous injection, but no tumours have been obtained in the experimental animals[12].

Thus, there is no evidence that any of the food dyes except Butter Yellow and *o*-aminoazotoluene are associated with carcinogenic properties. The use of these as food colours is probably now obsolete. In any case, it may be noted that the amounts used to produce tumours in animals were proportionately very much in excess of those which would be used to tint foods. It would be very difficult to determine whether repeated administration of small amounts of these food dyes during many years would be followed by tumours or other pathological conditions in the human subject.

Commercial colours which are used for dyeing fabrics are liable to contain toxic impurities, and for food colouring purposes specially purified dyes are manufactured. Analytical control, particularly in regard to certain metals, is important, and Dr. D. A. Harper and Mr. N. Strafford described methods which can be used for the rapid spectrographic determination of minute amounts of arsenic, lead, copper and other heavy metals in food dyes and medicinal products.

The determination of minute amounts of metallic impurities in organic substances by colorimetric methods is a time-consuming and expensive operation and consequently spectrographic methods possess many attractions. Although methods for the determination of traces of some metallic impurities in organic substances have been described the determination of arsenic has hitherto not been provided for. The present method will detect 0·5 parts per million of arsenic (As_2O_3), lead and copper, also antimony and tin if required. 1 gm. of the sample is wet-oxidized and the metallic sulphides precipitated along with cadmium sulphide, which acts as carrier and also as spectroscopic internal standard. The mixed sulphides are filtered off on a powdered graphite filter bed and, after drying, the mixture of sulphides and graphite is arced in the D.C. arc between graphite electrodes in front of the slit of a Hilger medium spectrograph. The tests are carried out in duplicate, and by means of a Hartmann diaphragm the spectra are photographed on both sides of the spectrum of a 'specification test' in which the same amounts of the reagent have been used and to which have been added the amounts of the metallic impurities corresponding to the specification limits. If necessary, additional standard spectra corresponding to limits both below and above specification limits can be employed. By examination of suitable spectrum lines it is possible to indicate whether each metallic impurity in the sample under examination is equal to, above, or below the specification limit, and an estimate of the actual amount of each present can readily be made.

The method is similar in accuracy to the usual colorimetric methods, and it offers considerable economies. When applied on 'mass production' lines the overall cost per sample is approximately one fifth of that of the colorimetric method. Of more importance in present circumstances is the fact that only one quarter to one third of the man-power is required.

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[1] Cox, H. E., *Analyst*, **54**, 694 (1929); **58**, 738, 743 (1933).

[2] Hashimoto, T., *Gann*, **29**, 306 (1935).

[3] Baer, H., *J. Amer. Med. Assoc.*, **103**, 10 (1934).

[4] See Blum, H. F., "Photodynamic Action and Diseases caused by Light", Chapter 23 (Reinhold, 1941).

[5] Traub, E. F., Gordon, R. E., and van Dyke, L. S., *J. Amer. Med. Assoc.*, **108**, 872 (1937).

[6] Climenko, D. R., *J. Amer. Med. Assoc.*, **109**, 493 (1937).

[7] Huggett, A. St. G., and Rowe, F. M., *J. Physiol.*, **80**, 82 (1934).

[8] Sasaki, T., and Yoshida, T., *Virchows Arch. f. path. Anat.*, **295**, 175 (1935).

[9] Kinosita, R., *Trans. Jap. Soc. Path.*, **27**, 665 (1937).

[10] Cook, J. W., Hewett, C. L., Kennaway, E. L., and Kennaway, N. M., *Amer. J. Cancer*, **40**, 62 (1940).

[11] Compare NATURE, **145**, 672 (1940).

[12] Kennaway, E. L., unpublished experiments.

THE CAUSE OF EARTHQUAKES

By ERNEST TILLOTSON

THE term 'earthquake' means vibrations of the ground. These vibrations are caused by the passage of various types of waves through the ground, which has elastic properties. The ground vibrations are kinetic energy, which must be released consequent on the disappearance of some form of potential energy. The form this potential energy takes, how it is released, but more particularly how it arises is the problem before us.

The data are multitudinous, and excellent recent papers covering some of the field are "Seismology" by Beno Gutenberg[1] and "Tectonic Processes now in Action"[2] by the same author. First consider the immediate cause. The potential-kinetic change might occur by sudden collapse, expansion or fracture. The first, caused by mining subsidences and the collapse of underground cavities, is of minor importance. The second may occur by chemical change or by change of state, for example, in magma basins or by sudden contact of percolating water with heat reservoirs—possibly causing such outbreaks as the Montserrat (West Indies) swarms. Apart from such phenomena and the fact that earthquakes and active volcanoes are associated with geologically recent mountain chains, there is little connexion between earthquakes and volcanoes. The third cause, by fracture, appears to be more frequent. Most normal strong earthquakes originate near the base of the 'granitic' layer at a depth of some 16 or 17 km. below the earth's surface ('sedimentary' layer 0–10 km. thick, 'granitic' layer 13 km. thick, 'intermediate' layer 26 km. thick), and it would appear that the immediate cause of most of these shocks is the application of pressure to rocks until they fracture. The total energy released by earthquakes per annum is near 10^7 kilowatts, and most of this is released by one or two great shocks. The focus of one shock as determined from instrumental evidence may be the place where fracture starts, though this fracture may spread quickly in any direction. That such pressure exists is sometimes first seen in extensive ground tilt; for example, the recent great Chillan (Chile) earthquake[3], though such ground tilt cannot yet be used to foretell the time or place of a possible future shock. Plastic flow or a succession of small shocks may alternatively dissipate the energy. Small foreshocks may presage larger earthquakes, though again such forerunners cannot yet be recognized as such. We have no independent means at present of probing the local strength of the 'granitic' layer to discover where rupture is likely to take place. Often between the accumulation of stress and the earthquake some small additional force such as an extra high tide, or great change in barometric pressure, perhaps a shaking from some independent distant earthquake or a mining subsidence may act as a 'trigger', thus releasing the larger energy.

Periodicities in earthquakes are still *sub judice*. With the present careful collecting of data better judgment may be passed after another 400–500 years. Artificial earthquakes caused by explosions of such material as gelignite (even the Oppau explosion—Jeffreys and Wrinch) only give rise to very minor pulsations. One of the strongest earthquake shocks has about 10^{25} ergs (Chile 1922); rather less energy was expended by the Turkish earthquake[4], less still by the San Francisco earthquake of 1906 and the Indian earthquake of 1934. To be humanly perceived an earthquake must have 10^{11} ergs, and to be recorded by a seismograph 10^8 ergs.

The long-range, or fundamental, cause of earthquakes would appear to be more important. What forces lead up to the rupture of rocks causing an earthquake and in what manner do they arise ? The forces are sometimes forces of compression, on occasion of tension and often they are shearing forces. Numerous combinations of these doubtless occur, and these may possibly arise in the following ways: Geosynclines are of paramount importance in the formation of large-scale sedimentary deposits, and in the compression of these deposits to form mountain chains. In depth the geosyncline must include the 'sedimentary', 'granitic' and 'intermediate' layers which altogether may reach a thickness of some 40–45 km. Flow to give some measure of isostatic compensation must begin at some distance below this. Should it so happen that as the deposition of sediments is maintained, the compensation keeps pace with it, the sides of the geosyncline might become so steep that tension would develop by gravity action in the various layers. If this tension is sufficient to overcome the cohesion in the rocks, these break up into blocks and the act of breaking gives rise to earthquakes. The folding of the sedimentary deposits in the bottom of the geosyncline may also cause earthquake shocks if the elastic limit of these rocks is exceeded and they fault instead of bending quietly. Geosynclines could scarcely be less than, say, 700–800 km. in horizontal extent and are often much larger. Their functioning must depend on the presence of a substratum underneath the 'intermediate' layer perpetually ready to yield under the action of loads above it. The yielding need not be continuous in time, and indeed several peculiarities are explained if it is not. A sudden yielding after a period of gradually increasing tension, compression or twisting would be much more likely to produce the sudden ruptures giving rise to earthquakes than a gradual continuous yielding.

Beds of rocks of different geological periods are separated in many places by unconformities and in others by sudden alterations in lithology. Periods of quiet deposition of sediments are followed by upheavals and then new conditions of deposition. Gradual transition from one formation to another is an exception rather than a rule. Does this not point to sudden accommodation isostatically in the basin of deposition showing that the yield point of the underlying material had been attained ? Joly assumed that this was caused by blanketed heating by radioactive material, though this need not be the only possible cause. The material may have an elastic yield point which the weight of the superimposed material may attain without the addition of heat. The period between a certain area being a basin of deposition and its rising to mountain peaks may be of the order of 10–100 million years, though in certain circumstances this estimate might be reduced. The forces are acting over long periods of time, and this may explain why we find with our limited period of observation that earthquakes tend to occur in the same localities as they have always occurred within the experience of our historical records. It is possible for a small basin of deposition to go through a cycle much more rapidly if the material underneath is sufficiently yielding. Minor oscillations within the geosyncline are sometimes apparent and perhaps the 'granitic' and 'intermediate' layers may yield locally.

The strength of the 'sedimentary' layer may be of the order of 10^9 or 10^{10} dynes per centimetre and the viscosity of the immediate interior according to one estimate is of the order of 10^{22} poises.

During such a period of yielding the sedimentary rocks may become folded and faulted, the process being accompanied by earthquakes with foci in the 'sedimentary' layer, seldom in the 'granitic' layer, and less frequently in the 'intermediate' layer. The movement may be started by any load of sufficient magnitude applied in one place such as the accumulation of ice during an ice age. Scotland and Fennoscandia are now rising after their Pleistocene ice has been melted away, while south-east England is falling at the rate of about a foot per century. This twisting may have set up strains in the upper layers, causing the North Sea earthquakes. Many of the Norwegian earthquakes are superficial.

Experiments made in the Geophysical Laboratory at Washington tend to confirm that rocks behave differently under forces gradually applied from what they do under forces applied quickly. The material of the earth's crust is continually tending towards hydrodynamical equilibrium. To this equilibrium the crust is continuously approaching with the passage of time, but the equilibrium is never absolutely attained owing to the resistive strength of the materials. This is Dutton's conception of isostasy. The work of Hayford, Heiskanen, the Indian Ordnance and Geological Surveys and others tends to show that although Hayford's numerical conception of isostasy has distinct computational advantages in geodesy, involving as it does gravity anomalies, yet on the available evidence it is effective over about one per cent of the earth's surface and ineffective over another 0·75 per cent. This is the extent of the earth's surface so far surveyed in this manner. Tests are now being made with seismographs in the neighbourhood of the Grand Coulee and Shasta Dams in the United States to see whether or not a small area suddenly loaded gives the necessary conditions for small earthquakes to occur. Numerous small earthquakes occur near Boulder Dam, but the pre-dam seismic history is not known.

Earthquakes with epicentres in areas subject to recent geological tectonic activity tend to have their foci in the 'sedimentary' layer, whereas foci in the 'intermediate' layer and down to 300 km. depths show some correlation with zones of Tertiary mountain building. There is still something to be said for the contracting earth theory though perhaps such forces as the *Polfluchtkraft* require more careful comment. Much seems to depend on the structure of, say, the upper 100 km. of the earth. The bed of the Pacific Ocean appears to be the only region in the world where the 'intermediate' and 'granitic' layers are absent. In the Pacific region the sima comes right to the surface, while elsewhere in the world sial overlies the sima. The vertical discontinuity is near the andesite line, and in North America it is apparent when seismic surface waves of about 20-sec. period and 70-km. wave-length cross from the Pacific Ocean bed to the land. There is much loss of energy. The discontinuity must extend at least some 25 km. down, but its vertical extent does not exceed 200 km. Such loss of energy is not apparent when similar waves cross other ocean beds, and if the evidence of seismic sounding is confirmed the North Atlantic depression has probably been caused by flexure and not by faulting.

Around the circum-Pacific line of instability in Japan, the Philippines and California, the directio of faulting shows the land moving southerly wit respect to the seaward side. Is this the *Polfluchtkra* at work in the Pacific region ?

The Atlantic and other regions would appear t be more doubtful. We must be careful, however not to take *all* surface faults to be the *cause* of earthquakes. The cause of an earthquake and its focus may be more deep-seated, and the surface fault ma be a *result* of the shock, not the cause of it.

Thus far we have not yet dealt with deep-focus earthquakes, that is, those with foci between 300 and 700 km. deep. The work of Scrase (recognition of *pP*, etc.), Turner (waves at the antipodes), and Stoneley and Jeffreys (small amplitude *L* and *M* show that these undoubtedly occur. The Brunner depth chart constitutes a quick working tool for finding such depths. It appears that these deep focus earthquakes could be caused by displacement resulting from the action of convection currents. The experiments of H. Bénard in 1900 showed the presence of convective 'cells' in fluid between two parallel surfaces maintained at different temperatures. Pekeris has continued this work. Deep-seated heat from th still molten core of the earth some 3,500 km. in radius may give rise to discontinuous geologically slow convection currents from this depth to, say, the 700 km discontinuity. This discontinuity may be between vitreous and crystalline basic material and is probably marked by a magnetic discontinuity also. Below 700 km., forces would be dissipated by plastic flow but just above 700 km. the forces might accumulat until rupture, causing an earthquake, could occur.

The part played by radioactive heat at these depth is uncertain, though heterogeneities in the interior are more important than homogeneities in deciding where convexion currents shall be, and where th elastic potential shall accumulate. Western South America, the Sunda Sea near Java, and the region between Japan and New Zealand are very activ regions at the moment. A series of observations o the direction of faulting taken over large areas o the earth's surface, also the careful integration o seismograms to discover the initial movement at the focus of deep-focus earthquakes would perhaps assist in finding the direction of deep-seated convection currents should these in reality exist.

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[1] Fiftieth Anniversary vol., Geol. Soc. Amer., June, 1941.

[2] *Trans. Amer. Geophys. Union* (1941).

[3] NATURE, Feb. 11, 1939.

[4] NATURE, Jan. 6, 1940.

RAMAN'S THEORY OF SPECIFIC HEAT OF CRYSTALS

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WHEN, in 1907, Einstein published his work on the specific heat of solids, nothing was known of X-ray crystallography. Crystals were apt to be regarded as a highly specialized form of solid matter Now, as a result of the wide application of X-ray analysis to all solids, the crystalline state is known to be the normal stable state of solids. Theoretically the crystal is a periodic three-dimensional grouping in space of an immense number of atoms, ions or molecules held together by interatomic or intermolecular forces. The unit cell, the smallest portion of the crystal to contain all the groupings of atoms characteristic of that particular form of the substance, is very much smaller than the smallest visible crystal. Nevertheless, the strength of diamond and the greasiness of graphite are inherent in the two different patternings of carbon atoms in the two different unit cells.

Properties of solids may be divided into the macroscopic, modified greatly by the shape and size of the individual specimen, and the sub-microscopic, inherent more in the patterning within the unit cell. This division of the physical properties of solids raises crucial questions when thermal properties are considered. On the kinetic theory of heat, heat is 'a mode of motion'. Are the thermal vibrations of atoms in a solid characteristic of the unit cell, or are they dependent more upon the size and shape of the particular crystal, differing for different crystals of the same substance? Sir C. V. Raman discusses these problems in a summary of his work published with six experimental studies on the subject in the *Proceedings of the Indian Academy of Sciences* (A, 14, November, 1941). The following is an account of the theory and of Raman's criticisms.

Raman's Specific Heat Theory

Let it be supposed that the thermal vibrations of a crystal may be described without reference to the fine structure of the solid. We shall be dealing with elastic vibrations. Their modes and frequencies will depend upon the speed of propagation of elastic waves and upon the dimensions and boundary conditions of the crystal. Oscillatory motions of large groups of atoms will be involved, and the larger the crystal the smaller would be the frequency differences between the successive possible modes of vibration. In the limit, the elastic vibrations of a visible crystal would give a continuous spectrum of frequencies. When, however, the wave-length of these vibrations becomes comparable with the size of the unit cell, the possibilities of another type of vibration must be considered. Here we should be concerned primarily with vibrations of atoms about their mean positions in the unit cell. The dimensions of the crystal would have a negligible influence and the frequencies of the vibrations would be much greater. Although the principal modes of vibration would be the same for all unit cells, larger-scale oscillations might occur in which there is a repetition in cells of a superlattice, the spacings being an integral multiple of the unit cell. All such vibrations would be monochromatic and would give approximately a continuous spectrum only if the number of types of superlattice was very great. In general, the first type of vibration would tend to give a continuous spectrum and the second a line spectrum in the infra-red region of the spectrum.

The distribution of thermal energy between the two types of vibration is treated as follows. The largest part of the thermal energy is taken to be that associated with the unit cell. If there are p atoms in the cell, there will be $(3p-3)$ modes of internal vibration and 3 translations for the cell as a whole. If p be fairly large, the $(3p-3)$ degrees of freedom appearing as vibrations would greatly exceed in number the 3 degrees of translation. Considering the superlattices and taking one in which the cells have twice the edge-length of the lattice cells first chosen, we have $(24p-3)$ modes of internal vibration of the atoms and 3 translations. The former $(3p-3)$ modes of vibration will be included, as well as others approaching them in character. In addition, new modes of vibration previously reckoned as simple translations of the unit cell would occur. Unless p is very small, not many superlattice vibrations need be considered. The number of vibrations of the elastic type bears to the total number of degrees of atomic freedom a ratio of the same order of magnitude as the ratio of the volume of an individual atom to the cube of the limiting wave-length. When, therefore, the wave-length limit is even moderately large in relation to the lattice spacings of the crystal, the energy of such vibrations is a negligible fraction of the whole.

The Debye Specific Heat Theory

The specific heat theory of Debye is criticized by Raman on the grounds that it associates the thermal energy of the crystal with that of elastic vibrations. Experimentally it is found that elastic vibrations travel with high speed, whereas heat energy travels very slowly indeed, at diffusion rates. The limits of using a discontinuous structure as an approximation to a continuous structure or vice versa are illustrated by the well-known example of the modes of vibration of a periodically loaded string and of a uniform string. While the specific heat curve can be uniquely derived from the vibration spectrum, a knowledge of the specific heat data is insufficient for a determination of the vibration spectrum. The Debye formula with an appropriately chosen limiting frequency fits the specific heat data in certain cases, but fails for several elements crystallizing in the cubic system. The Debye function is the integrated sum of a continuous sequence of Einstein functions over a range of frequencies with weights proportional to their squares and a sharp cut-off at an upper limit. Experimental data which fit a Debye function should therefore equally be capable of being represented as the sum of a finite number of Einstein functions with appropriate frequencies and weight factors.

In Einstein's earliest papers, he pointed out that approximate relations between atomic frequencies and elastic constants were to be expected from elementary considerations. No special significance can therefore be attached to the fact that elastic constants calculated from the specific heats come out of the right order of magnitude.

Born's Theory of the Cyclic Lattice

The Born theory is criticized on the grounds that in essence it is based on concepts derived from the macroscopic behaviour of elastic solids of the same kind as are used by Debye. Born's theory rests on his postulate of the 'cyclic lattice'. All the atomic displacements are taken to be periodic in a volume having the same shape as the unit cell of the lattice but of very great size in comparison with it. The postulate makes no distinction between the atomic vibrations of high frequency and the elastic vibrations of low frequency. All the possible vibrations are assumed to have wave-lengths which are submultiples of the external dimensions of the crystal. This is in contrast with the Raman theory, where the unit cell or integral multiples of it are taken as determining the characteristic vibrations. The size of crystal would affect the modes of vibration only in so far as the unit cells at the surface of a crystal differ from those in the interior. The differences would be of the order of the difference of specific heat as determined with a single crystal and with the same mass of small crystals.

Spectroscopic Data

Whereas the Debye and Born theories lead to vibration frequencies of a crystalline solid giving a continuous spectrum, the Raman theory leads to a line spectrum. The relevant experimental data may be got from studies of the Raman spectra, the luminescence of crystals excited by light or by electric bombardment, and the absorption spectra.

A striking feature of the spectrum of the radiation scattered when a monochromatic beam traverses a transparent crystal is the *sharpness* of the lines of displaced frequency appearing in the infra-red. This feature is characteristic of the lines associated with either extensional or distortional vibrations of the ions or molecules in the crystal lattice or with translational or rotational motions. The latter type fails to appear when the substance is in the amorphous or fluid state, being then replaced by a diffuse continuum. The monochromatism of the vibrations is therefore closely associated with the crystalline state. Two plates are reproduced showing this monochromatism associated with superlattice frequencies for quartz and diamond.

Detailed studies of the relevant data have been made in the Physics Department of the Indian Institute of Science, Bangalore, and are presented in a series of six papers. R. Norris deals with white phosphorus and quartz, B. Dayal with the cubic metals (lithium, tungsten, gold, silicon and grey tin) and with the hexagonal metals (magnesium, zinc and cadmium), V. B. Anand deals with diamond and C. S. Venkateswaran with alkali halides. Good or improved agreement of theory with experiment is found by using the Raman theory instead of the Debye theory. Numerical comparisons using the Born theory appear to be missing. The bulk of the thermal energy is associated with unit-cell frequencies appearing as monochromatic lines in the infra-red. The residue, associated with superlattice frequencies, appears in the remote infra-red, is monochromatic and is relatively important only at low temperatures.

ADVANCE IN INVENTION: ITS RELATION TO WORLD PEACE

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A YEAR after the outbreak of the present War the results were published of a study of the causes of the failure to preserve peace. The members of the study group are described as mainly officers of international organizations with headquarters at Geneva, meeting unofficially and able therefore to contribute to the discussion without reserve. The publication was issued under the authority of the Carnegie Endowment for International Peace.

World Unity

The factors that led to war are classed under three heads: political, economic, spiritual. But all three, when critically examined, are revealed as a failure to visualize the world as an organic whole. "The most startling example of the collective failure" to take a world view, under the political head, they say "was the attitude adopted toward Germany, not only in the clauses of the settlement, but still more in the manner of their presentation. . . . In particular, the refusal to negotiate with Germany created an attitude of mind in that country that was never subsequently changed." Put the rulers of Germany under restraint; yes. Make the German people suffer; impossible, unless we are prepared ourselves to suffer with them. However much they may appear to our limited vision to deserve punishment, by placing them in the dock we shall but bring judgment upon our own heads. We are reminded of an illuminating analogy due to that far-sighted statesman, Señor S. de Madariaga: "A nation, a limb of the world, misbehaves, i.e., it acts against the world community, which is the whole body. And sanctions are decided on to punish it. But, can we punish a limb without punishing the whole body?" If we sow the wind, we reap the whirlwind.

The fundamental character of this principle of world unity comes out nowhere so clearly as in the economic aspect of international relations. The Geneva group recall the sequence of events following the attempt to extract huge reparations from Germany. Failure to grasp the fact that payment in goods would immediately put large numbers of people in the allied countries out of work may be taken as evidence that the mismanagement of affairs after the War of 1914–18 was due in large measure to a lack of understanding of elementary economics. It was as much a failure of the head as of the heart. Happily there are signs of greater enlightenment among those who are at present responsible for advising the leaders of the democratic Governments in such matters. In particular, they are fully aware of the consequences of the remarkable progress achieved in technological invention. This was causing so great a revolution in industrial production, even before 1914, that it was bound sooner or later to lead to trouble between nations if each attempted to pursue its own self-interested path regardless of the welfare of others; and this new industrial revolution may cause still greater disaster after the present War if its implications are not more widely and clearly realized. It is essential that Governments should be able to depend upon the support of public opinion for any concerted measures they may adopt for the control of output and its distribution, in the interests of the world as a whole and especially of the weaker nations.

Progress in Output

A few facts may be given which bear striking witness to the extent and the rate of advance in the output capacity of modern machinery. Colin Clark has made a comparison of the real income produced per head of the working population in different countries on the basis of a 48-hour week. His figures indicate a rise in Sweden and Japan to a level more than four times as high as that reached seventy or eighty years ago. In most highly industrialized countries the income so calculated has been at least doubled during the same period of years, and this was accomplished in spite of a considerable increase in population and decrease in the hours of work. In the last two decades the rate of progress has been even more astonishing. According to an estimate published by the Royal Economic Society, the increase in physical output per operative in the United

Kingdom, for all industries covered by the Board of Trade Census of Production, was 34 per cent between the years 1924 and 1935 and 27 per cent during 1930–1935. For engineering the corresponding increase, 1930–1935, was 57 per cent; for textiles, 37 per cent.

Even allowing a considerable margin of error in all these figures, there is not the least doubt about their general trend. Moreover, the wide range of invention is as striking as the acceleration in output. The telephone, the motor-car, the aeroplane, the motion picture, and radio have had so far-reaching an influence upon the structure of society—turning almost unknown nations into next-door neighbours overnight—that it is only with a jerk of memory we recall that they are largely the product of the present century. About a million telephones were in use and the motor-car was just being introduced into the United States forty years ago; now the telephone industry is the third largest public utility concern in the country and there is one motor-car for every five people. The aeroplane was regarded with scepticism and the other two inventions were as yet unknown. These facts are mentioned by Prof. W. F. Ogburn in a recent American publication, which directs attention also to the immense and fascinating possibilities the future holds for us, arising out of the discovery of synthetic resins and plastics; rayon, artificial cotton, and wool derived from cellulose; synthetic rubber and wood substitutes; devices such as the photo-electric cell, and many other inventions.

What does all this imply? It should surely imply a fuller and more varied life for all mankind, if only we could agree upon a fair method of sharing the products of hand and brain. There comes the hitch. The new industrial revolution burst upon us unprepared; we all know how a few primary producers were driven in sheer desperation to destroy their surplus stock, after a vain attempt to dispose of the overwhelming output of certain commodities at remunerative prices. Is there no danger that the same conditions will return when this War ends? The urgency of essential war requirements speeds up output enormously and sharpens inventive wit. It is certain, therefore, that the pace and capacity of production of our machines will be very much greater than they were when the War of 1914–18 ceased. Past experience proves, too, that it will be a relatively simple matter to change over from war to peace production. Yet, before this War started, it was estimated that the people of the United States, to take but one example, could subsist if necessary on about one third of their output, leaving the remaining two thirds to be devoted to other purposes. What is true of the United States is true, in varying degrees, of other equally advanced countries.

Problem of Surpluses

This presents the problem of surpluses in a new and significant light. It is clear that under conditions of peace, if our aim is to provide employment for all who are capable of work—since sharing the work available, by a general reduction in the weekly hours of labour, would only be a partial solution of the unemployment problem—the potential supply of many commodities, with full employment, will far exceed the effective demand for them within the country of their origin. What then can the United States, for example, do with her vast surplus? She can only hope to exchange a relatively small part of for the few commodities which she cannot herself produce. As for the rest, she has a choice of four courses: she can destroy it, which no one would commend; she can store it or sell it on long credit, but either of these two courses would only put off the day of reckoning and make the problem more difficult to solve eventually; the one choice left open is to give it away to nations whose need is greater than her own. To put this last suggestion into practice, though at first sight revolutionary, would be entirely consistent with the fundamental principle of world unity, whereby all the peoples of the world are regarded as one people, one family of nations. The average real income per occupied person in the United States has been very roughly estimated at one hundred dollars a month; the corresponding figure in India or China would be equivalent to five or ten dollars at most. There is a like discrepancy between the standard of living among these Asiatic peoples and that which we in Great Britain enjoy, and the difference is a measure of our responsibility towards them. A carefully planned scheme of assistance, covering all aspects of life, would in course of time result in greatly improved conditions in both India and China.

How is such assistance to be given? Let us suppose that, with the return of peace, a time comes when we have in use all the labour we can effectively employ to satisfy our own needs, but that many men are still without work and our machines are not running at full pressure. Manufacturers are unwilling to take the risk of increasing their production, because they anticipate no increase in demand in the home or foreign market at existing prices. There are two courses then open. The Government may maintain these potential workers in idleness, which is bad for everybody concerned. That was the policy adopted after 1914–18. The alternative is to find work for them. India and China are in sore need of tractors and other agricultural implements. They might indeed be able and willing to pay for them with rice, tea, silk and other commodities if the price asked were not too high. But it would be far better for the British Government to make free gifts to these countries than to permit our labour force and our plant to deteriorate by remaining idle. The cost of the creation of any additional credit notes needed would be trifling, and no money is wasted, in the sense of being used up, by circulating it. Contracts would be given to engineering firms in the normal way; they would be paid fair prices and the workmen would receive good wages for the work done. Their increased earnings would result in increased expenditure, bringing extra gain to shopkeepers and others, besides extra revenue to the Government in taxation. It is thus evident that, by helping to raise the standard of living of depressed peoples, our own standard would rise simultaneously. No nation can move forward at the expense of others: we can only advance together—yet another illustration of the organic unity of the world.

International Pool Control

It should be a relatively simple matter, therefore, to accumulate a pool of surpluses of many kinds from Great Britain, the United States and other advanced countries. This pool might be placed under the control of an International Advisory Council, composed of experienced men and women of the highest integrity, capable of taking a world view in the handling of the delicate problems arising between nations. Such a Council, assisted by fact-finding Commissions of economic and other specialists, would command high authority. It would express a reasoned opinion for the guidance of Governments as to the wisest and most just plan for the control of world production and the disposal of surpluses, based upon a judicial and expert examination of all the data available. The relatively rich countries could be credited if they so wished, at agreed nominal prices, with any 'gifts' they contributed to the pool, and these credits would be regarded as giving them a call upon the pool at any future time should they themselves be in need.

It is not too soon to consider the setting up of an Advisory Council now. The judges of the Permanent Court of International Justice, seeing that they have established for themselves a reputation for wisdom and impartiality, might be invited to prepare a scheme for the selection of a panel of suitable people to serve upon it. Plans are already under discussion for the feeding and restoration of the famine-stricken inhabitants of European countries. It is too big a task for ourselves and America alone; all countries should take pride in working together for this purpose. It might well be handed over to such a body as the proposed Advisory Council. The disposal of surpluses and the feeding of the hungry are clearly complementary problems: the solution of the first is the key to the solution of the second.

One fundamental difference is to be noted between this approach to post-war problems and the Conference method adopted after the War of 1914–18. We leave the arena of politics, where each nation has its own ends in view, and become intent upon an objective and scientific task: seeking to satisfy, out of our common store, the elemental needs of all peoples. Upon that sound moral and psychological basis it should be possible to go on to build a peaceful World Order.

METEOROLOGICAL RESEARCH IN GREAT BRITAIN

AIR MINISTRY RESEARCH COMMITTEE

THE importance of meteorology to aviation has necessitated an extension of the State meteorological service far beyond the modest dreams of meteorologists of the last generation. At the present time meteorological forecasting is a vital element in the national war effort, especially in the conduct of the offensive; but the return of peace and the renewed expansion of civil aviation will maintain the need for weather prediction, which also has great importance for agriculture and many other branches of the national economy.

The science and art of weather prediction have made great progress during the present century, but it remains uncertain whether even now all the fundamental factors that determine the weather changes have been discovered, and also whether the programme of observation yet includes all the elements necessary as a foundation for prediction. The problems both of observation and of theory are extremely complicated. It is therefore desirable that, along with the day-to-day application of the knowledge already available, proportionate efforts should be made to improve our knowledge and our methods.

For this reason the Secretary of State for Air has recently appointed a Meteorological Research Committee to advise and assist in the carrying out of meteorological investigations. The Committee is constituted as follows: Prof. S. Chapman, professor of mathematics at the Imperial College of Science and Technology (chairman); Prof. D. Brunt, professor of meteorology at the Imperial College of Science and Technology; Dr. G. M. B. Dobson, reader in meteorology in the University of Oxford; Prof. G. I. Taylor, Yarrow research professor of the Royal Society; the Director of the Meteorological Office; the Director of Scientific Research of the Ministry of Aircraft Production; the Director of the Naval Meteorological Service; and representatives of the Air Staff and civil aviation.

At present the Committee will naturally be concerned chiefly with problems directly concerned with the war effort, and such work must for the time being remain secret, though any incidental results not likely to be of service to the enemy may be published.

The Committee would welcome contact and cooperation with university departments or other institutions engaged on work that bears on meteorology; as a result of inquiries in the United Kingdom, information concerning such work, and offers of assistance, have been received from several universities. Correspondence, which should be addressed to the Secretary, Meteorological Research Committee, Meteorological Office, Air Ministry, Kingsway, London, W.C.2, is invited from any other university or research institutions which can assist in this work.

Co-operation of the Royal Society

The formation of a Meteorological Research Committee by the Air Ministry, announced above, is an important and very welcome advance in the organization of British meteorological research. The Air Ministry Committee will at present confine its work chiefly to those problems which have an immediate practical application and are likely to be solved in a fairly short time. The Royal Society has been invited by the Air Ministry to co-operate with the Meteorological Research Committee by undertaking research on certain aspects of meteorology which, though of fundamental importance for the advance of the subject, may not have an immediate practica application.

The Council of the Royal Society has agreed to this request, and has entrusted the immediate responsibility for the work to the Gassiot Committee. This Committee, first constituted in 1871, was originally appointed to administer the Gassiot and other trust funds applicable to the maintenance of certain British meteorological and magnetic observatories, and to make recommendations as to their work. The terms of reference have now been enlarged to include the supervision of fundamental meteorological research such as has been asked for by the Air Ministry The personnel of the Committee is appropriate for this purpose; the chairman is Dr. G. M. B. Dobson, and the members are Sir Edward Appleton, Profs D. Brunt and S. Chapman, Sir Henry Lyons, Sir George Simpson, Prof. G. I. Taylor, Sir Gilber Walker, the Astronomer Royal, the President of the Royal Astronomical Society, the Director of the Meteorological Office, and *ex officio*, the Treasurer o the Royal Society (Prof. T. R. Merton) and the Secretary of the Royal Society (Prof. A. C. G Egerton).

These arrangements seem eminently suitable because pure fundamental research which may hav to be continued over a long period, and which requires the co-operation of many independent workers in university departments and laboratories, can probably be organized more easily by the Royal Society than by a Government department, however much the latter may be in sympathy with the object of the researches. The Royal Society has already shown its willingness to further such work by appointing Dr. E. Glückauf to a Mackinnon Studentship, to enable him to carry out meteorological research under the general guidance of the Gassiot Committee.

The general research in which the Air Ministry has sought the co-operation of the Royal Society is that of radiation in the atmosphere, with special reference to radiation equilibrium conditions in the stratosphere. It is fairly generally accepted that the average temperature of the stratosphere—as of the warm region above it—is determined by an equilibrium between the energy absorbed, from both the downward solar radiation and the upward terrestrial radiation, and the energy radiated by the air in the stratosphere. Observations have shown that there are large variations of temperature in the stratosphere both with time and with place, but we know little as to why such variations occur. Few meteorologists, for example, would care to be dogmatic as to why the stratosphere is some 50° C. *colder* in equatorial regions than in polar regions.

The principal gases of the atmosphere are mostly very transparent to radiation, and the radiative conditions are largely governed by such minor but polyatomic constituents as water vapour, carbon dioxide, ozone and possibly others. To understand the radiation equilibrium in the atmosphere, it is necessary to know (*a*) what gases are present which have important absorption bands for radiation; (*b*) in what proportions they are present at different levels; (*c*) how gases such as ozone are formed and decomposed; (*d*) the absorption coefficients of these gases for different wave-lengths, and whether the absorption and emission spectra have a continuous or fine line structure. Finally, when the above facts are determined, it will be necessary to calculate the radiation equilibrium temperatures at different levels and to determine how rapidly the temperature will change when the conditions alter.

The Gassiot Committee has been fortunate in enlisting expert help in particular branches of the subjects involved, and has formed three sub-committees to deal with different aspects of the above question. It is hoped in this way that the available relevant knowledge will be collected, and that those questions which require more experimental work may be defined, so that arrangements can be made for the work to be done, so far as this should prove possible under present conditions.

Dr. G. M. B. Dobson is the chairman of Sub-Committee A, which will deal with the chemical analysis and the observation of the amounts of the polyatomic constituents of the air at different levels; other members of this sub-committee are Profs. H. Dingle and F. A. Paneth, and Dr. E. Glückauf.

Sub-Committee B will deal with the photophysics and photochemistry of the atmosphere, from the highest levels downwards, and, in particular, with the changing equilibrium of ozone and any other variable polyatomic constituents; the chairman of this sub-committee is Prof. H. W. Massey, and the members are Prof. K. G. Emeléus, Dr. W. C. Price, and Dr. J. Sayers.

Sub-committee C will consider the radiation balance in the atmosphere; its chairman is Prof. S. Chapman, and its members are Prof. D. Brunt, Dr. G. S. Callendar, Dr. T. G. Cowling, Dr. A. R. Meetham, Sir George Simpson, and Dr. G. B. B. M. Sutherland.

There will be few who will not agree that the first meteorological problem thus selected for attack is a very important one, and still fewer who will dispute its difficulty. It is hoped that the scientific effort which the Royal Society can bring to bear on this work will lead to substantial progress. The Gassiot Committee is aware that at laboratories and institutions in many parts of the world work has been undertaken that bears on these problems, and the Committee would welcome co-operation in cases where the continuance of such work is possible in present circumstances.

SCIENCE AND TECHNOLOGY IN THE SOVIET UNION

SCIENCE and technology in the Soviet Union was the subject of the first of the two symposia held over the Easter week-end by the Faculty of Science of Marx House (Marx Memorial Library and Workers' School) at the London School of Hygiene and Tropical Medicine. Prof. J. B. S. Haldane presided and nine speakers took part in the two sessions. The second session, on Race and Fascism, was dealt with in Nature of April 18, p. 426.

Prof. J. D. Bernal spoke on physical science in the U.S.S.R. A great deal of fundamental work has been done in the Soviet Union and many difficulties have been overcome. In 1920 there were only forty trained physicists in the whole country, but by 1934 in the big institutes in Leningrad there was a six years course which was more rigorous than that in the Cavendish Laboratory. Since then tens of thousands of physicists had been trained. Physics played a vital part in the general plan of development and in the preparations for the expected attack on the country.

As an example of the manner in which the fundamental problems studied arose from the needs of Soviet economy, Prof. Bernal took the transmission of electric power. Power losses which were trivial in Britain became serious because of the great distances in the Soviet Union. The properties of insulators had to be studied and this required fundamental work on the passage of electricity through crystals and on the quantum theory of the solid state. In the metal industry, also, problems arose which led to a rapid development of crystal physics under Joffe and to the working out of a dynamic theory of plastic deformation. Rehbinder's discovery that the hardness of metals varies according to the surrounding medium is a fundamental one and has already led to changes of technique in dealing with metals.

Science is planned in the U.S.S.R. as a part of economy as a whole on the basis that, statistically, the results will be proportional to the effort applied in any particular field. Only the general requirements are given from outside, and the Academy of Sciences works out in general where the main lines of attack should be made. Each group of workers in each laboratory settles its own problems of how to go about the work. To-day the whole of Soviet science has been turned to the job of winning the War, to the problems of the production and use of new weapons, to the reorganization of industry in new areas, and to the discovery of new materials and sources of supply. The present lack of contact between Soviet men of science and those of other countries is very much to be deplored, and knowledge of what they are doing would help us to realize in a rational way the possibilities of science for a new civilization.

Mr. H. P. Vowles, speaking on electrification in the Soviet Union, said that Lenin, with his genius for applying Marxist theory to a concrete situation, realized very early that the new Soviet State would be menaced from within as well as from outside so long as small-scale methods remained the dominant mode of production. He realized that it would be impossible to build up large-scale production without electrification, hence his well-known saying that in Russia "Socialism was the Soviet Power plus Electrification". On Lenin's initiative the Commission on Electrification known as GOELRO began work and soon achieved the first success of the new State in industrialization.

Mr. Vowles stated that, although the United States still leads the world in output per capita of electricity, the Soviet Union has drawn level with that country in many features of electrification and has surpassed it in rate of electric development, in the development of heat and power stations, in the mechanization and electrification of agriculture and in the correlated planning of production and consumption of electricity. The United States originally took its engineering technique from Britain, but from 1850 Britain drew increasingly on American technology and skill. The Soviet Union has been greatly indebted to the United States for the technique of power production, but already after the short period of twenty years the Americans can learn much from Soviet electrification.

Dr. N. F. M. Henry discussed the part of geology in Soviet economy. He showed that although there were a few geologists of international standing in Tsarist Russia, less than 1 per cent of the vast area of the empire had been mapped on a scale of ¼-inch to one mile. From the beginning, the Soviet Government paid special attention to geology because the fundamental position of this science in the building of a socialist economy was realized. The electrification and industrialization of the country urgently demanded coal, iron and large supplies of many other mineral substances. Because of the great distances involved it was of vital importance to develop mineral supplies in many parts of the country. It was impossible to survey the 8 million square miles of the Soviet Union square by square as was done in Britain over a period of a hundred years. Soviet geologists were faced with a double problem of teaching thousands of young geologists and of developing geochemical theory as a guide to the rapid study of the most suitable areas for mineral exploitation. The mineral output of the Soviet Union to-day is evidence that these big problems were tackled with energy and with very good organization. It is no accident that Soviet men of science should lead the world in geochemistry, for its development was urgently demanded by the needs of Soviet economy.

In 1936 the total amount spent on geological work was 1,000 million roubles (about £38,000,000), but in March 1938 it was officially stated that this was to be doubled. The permanent scientific staff of the Central Institute for Geology numbers 500, but the total number of geologists and prospectors working under its control is about 10,000. These figures show the importance of geology to the Soviet Union, and this importance is reflected in the tremendous public interest in the subject. Millions of school-children study it in the field and in the laboratories of the Pioneer Palaces. The man in the street often reads of the latest discoveries, and the leading geologists are public figures.

Mr. H. Rose spoke on aspects of Soviet developments in chemical engineering, dealing in particular with the underground gasification of coal and with the Soviet rubber industry. While proposals for the underground gasification of coal were first made many years ago by Mendeléeff, and by Sir William Ramsay who actually carried out trial bores in Great Britain, it was Lenin who first paid serious attention to the possibilities opened out by this revolution in technique. In 1937 experimental shafts were sunk, after much careful preparation, in the Donbas. The successful development on a wide scale which was begun in 1940 was made possible by the work of Kapitza, who recently received a Stalin Prize, on the low-pressure liquefaction of air, because a cheap supply of oxygen is required to improve the quality of the gas.

The social and economic implications of this new development are of tremendous importance, for one man can now do the work of ten miners. Mr. Rose believes that technical developments in steel blast furnaces will probably do away with the need for mining coal even for metallurgical coke, and then in the Soviet Union the hard and dangerous occupation of underground coal mining will disappear completely.

Although scientific men such as Kondakov and Lebedev, working under the old regime, made considerable contributions to the early study of rubber, it was not until after the Revolution that this study developed enormously and led to the production of synthetic rubber on a large scale from 1931 onwards. To-day the Soviet Union is probably the largest producer of synthetic rubber in the world, and 80 per cent of her requirements are now satisfied by the synthetic product. In addition, the rubber problem is being solved by the rapid development of the natural rubber-yielding plants Kok-Sagyz and Tau-Sagyz.

Dr. M. Ruhemann dealt with low-temperature research and development. He spoke in particular about the separation of natural and industrial gases, which necessitates the use of low temperatures and refrigerating machinery. The studies of Soviet scientific workers on the phase equilibria of different gaseous mixtures and of the solid-liquid mixtures of several binary and ternary systems are now well known. These findings were applied to coke-oven gas, and important results were soon obtained, such as the extraction of hydrogen of 97 per cent purity and the development of a new method of obtaining krypton. As a result of this scientific research, the Soviet Union now has a larger gas separation industry than any other country in the world, and this is of great importance for the heavy chemical industry.

The afternoon session was opened by Prof. J. B. S. Haldane, who spoke on the biological sciences in the U.S.S.R. In biochemistry, work has been done on the way in which a protein 'gets itself copied', and the emphasis has been on the study of processes rather than on the isolation of substances. In sheep genetics the Soviet Union is well ahead, and the beginnings of a chromosome map for sheep are now visible. New species of plants have been produced, such as an octoploid wheat, and the great work of Vavilov on the systematics of cultivated plants has led to the development of types suitable for many parts of the vast territory.

Umanski's discovery that cancer tissue will act as an organizer is very important, and work is proceeding on the study of the conditions necessary for tissue to be capable of being organized. In medical techniques several advances have been made. The transfusion of cadaver blood is a regular procedure now, and it has been found that it is more effective than blood from living donors, although the reason for this is not yet known. The grafting of tissues from corpses was based on the idea that the distinction between life and death and between different organisms is not so fundamental as has been thought. By the use of such processes, Filatov and his assistants have probably restored sight to more people than all other surgeons in the world put together.

Soviet biology is linked not only with agriculture, but also with the development of fishing, hunting, the timber industry, and very closely with medicine. Nevertheless, it does much work of fundamental importance which is altering our theoretical approach to many biological problems.

Mr. J. L. Fyfe made a contribution on the genetics controversy in the U.S.S.R. In his opinion the clash between the geneticists and Lysenko, a physiologist, arose because of the close relation between science and technical needs. Vernalization is the opposite of plant-breeding in the sense that it is designed to produce improved forms of crops by treatment, not to select them by testing. The special importance of vernalization in the Soviet Union is its speed as compared with plant-breeding. In 1931 Stalin said that the Soviet Union was fifty or a hundred years behind the advanced countries, and he gave the country ten years to make up leeway. Prejudices have obscured the issues, and this controversy has developed in a period of strong anti-Soviet propaganda. Mr. Fyfe went on to discuss the relation between genetics and the ideas of Lysenko. These ideas are in many ways contradictory to the basic postulates of genetics, but it is significant that recent developments in genetics itself are doing very much the same thing. Genetics is thus approaching a crisis, and the work and ideas of Lysenko are contributing to this developing crisis. The crying need, however, is for careful experimental work to test the theories of Lysenko, for it would be as foolish to set him up as an infallible prophet as it is to dismiss his work lightly.

Mrs. Beatrice King spoke on science in Soviet school education, which, she said, can only be understood in its social and economic setting. In the struggle of an economically backward country to transform itself in a few years into an advanced one through the building of a socialist economy, science has been of prime importance. In education, also, the Soviet Union has passed through a period of intense struggle to become an advanced country and to develop among the people the scientific outlook which is essential for the building of socialism.

In school the approach is historical and international, and science is directly linked with social and economic problems so that children learn at an early stage to think scientifically and not to regard science as a separate subject. All children study scientific subjects experimentally as well as theoretically, but there is no specialization in ordinary schools. The text-books which are used in schools and in universities are generally the work of several writers and are always tried out for a year before being finally approved.

Outside school, science plays a large part in the lives of the children. Science and scientific discoveries bulk largely in the literature of children of all ages, while their plays and films often have scientific subjects. The children's Pioneer Palaces always have laboratories, and school science and exploration clubs flourish, while excursions to the country and to museums and regional-study holidays are attended by millions of children every year.

Dr. M. Ruhemann spoke on the scientific worker in Soviet society. Soviet men of science have closer contact with other strata of the population than is the case in Western countries, and they react to the pressure of public opinion from a people which has learned to respect science and to expect a lot from it. In most cases students receive a stipend from the State during their five-year course. The best students can proceed to do research work with increased stipends and are entitled to all the help that their seniors can give them. As a member of the same trade union as all other employees in the institution, whether technical, scientific or office workers, the man of science becomes bound up with the life of the institute. The intense Soviet life around, the unlimited scope for solving practical problems, and, finally, the basic Marxist conception of science as the foundation of technique and of the development of the productive forces of society make the scientific worker a conscious and enthusiastic citizen.

The whole symposium was attended by about 250 people, and Marx House is to be congratulated on the organization of such a successful set of meetings. These symposia constitute a valuable contribution to Anglo-Soviet unity and understanding.

THE SCIENTIFIC WORK OF ELIE METCHNIKOFF

By DR. G. F. PETRIE
Lister Institute

THE heightened interest in the cultural and intellectual activities of the U.S.S.R. has stimulated a desire to know more about the work of outstanding Russian men of science who belong to the recent past, and thus the anniversary of the birth of Metchnikoff on May 16, 1845, is a fitting time to survey his achievements and to indicate the significance at the present day of his fundamental work on the role of phagocytosis in inflammation and immunity.

Metchnikoff's training as a zoologist was of the greatest value to him throughout his life in guiding his researches, and indeed in consequence of it he was led to the central point of his theory of immunity, for during his stay at Messina in 1882 he made his observations on the mobile cells of a transparent starfish larva and conceived the idea that similar cells might serve to defend the organism against intruding particles whether these were living or non-living. A simple experiment carried out on the spot went far towards establishing the proof. As he himself wrote: "A zoologist until then, I suddenly became a pathologist." During the next twenty-five years the theory was extended by Metchnikoff and his pupils and by numerous workers in many parts of the world to include bacterial infections such as anthrax and erysipelas, with the result that ample evidence of the importance of phagocytosis as a means of disposal of intrusive bacterial elements was forthcoming.

Metchnikoff was fortunate in his choice of scientific associates and of the milieu in which his life-work was done. On his first visit to Pasteur in 1887 he was kindly received and was offered a laboratory in the then newly built Institute in the Rue Dutot, whereas, soon afterwards, Koch in Berlin and Emmerich in Munich gave him such a cool reception that he decided to accept Pasteur's offer, and thus in October 1888 he entered the most fruitful period of his career, which lasted until his death in 1916 at the age of seventy-one.

The controversies on the rival doctrines of immunity upheld by the French and the German schools—which, on one side at least, gave the impression of national partisanship—are now of merely historical interest. The humoral theory to which the German workers obstinately clung was based on the direct bactericidal action of the blood-serum of normal and, in particular, of immunized animals. The view now held is that active phagocytosis depends upon sensitization of the bacteria by bacteriotropic substances that are present in normal and immune sera. The two points of view are thus by no means mutually hostile; they are indeed complementary and their relative importance varies with the particular instance of an infective process that is chosen for illustration. After Metchnikoff's death, Aschoff and other workers systematized the cellular theory of immunity by defining the types of cells scattered throughout the tissues and organs of the body that are capable of functioning as phagocytes; these form the so-called reticulo-endothelial system of cells. This scheme of classification has conduced to precision and convenience of description. Recent studies of phagocytosis have been numerous and have been directed towards elucidating the finer mechanisms of the process as revealed by physical and physico-chemical methods. The romantic attribution to the phagocytes of purposeful activities as defenders of the citadel of life against bacterial invaders, which so impressed the popular mind in the last decades of the nineteenth century, has given place to more prosaic interpretations. Experimental work has thrown light on such problems as the part played by the nature of the surface of the particles exposed to phagocytosis; the influence of the *p*H of the surrounding medium upon the exposed particles and upon the phagocytes; the influence of temperature, of surface forces, and of the viscosity of the cell protoplasm upon the intake of particles; and the differences that are observed in the functional activity of leucocytes when these are collected from healthy and diseased subjects.

Metchnikoff's researches included studies on the comparative pathology of inflammation, a process in which phagocytosis is one of the chief manifestations. His observations on chemotaxis and on intracellular digestion of bacteria engulfed by the phagocytes have not been disturbed by the newer knowledge. There still remains, however, for solution the refractory problem of the deviations from the normal of the biochemical activities within the local phagocytes and fixed tissue cells; these changes must be assumed to vary both in quality and degree throughout the phases of the inflammatory process until the lesion has healed.

The general interest aroused by his work on the transmission of syphilis to chimpanzees and on the prophylaxis of the experimental disease by the inunction of mercurial ointment is still remembered. Metchnikoff had a passion for probing into the mysteries of life and death, as is shown by his own mental reaction to his approaching dissolution, but it would seem that in his views on the production of senile changes in the tissues caused, as he thought, by intoxication from harmful intestinal bacteria, his imaginative powers outran his judgment; the habit of drinking sour milk as a preventive measure against ill-health and premature old age has now disappeared. Nevertheless, his work has encouraged the important study of the physiology and pathology of senescence, and within recent years this subject has engaged the attention of an enthusiastic group of scientific workers in the United States and also in Great Britain.

Metchnikoff was international in outlook both as a man of science and as a humanist, and here it is worth quoting a sentence from the warmly expressed tribute of Emile Roux, his friend and colleague, on the occasion of Metchnikoff's seventieth birthday. "Resté Russe de nationalité, vous êtes devenu Français par votre choix et vous avez contracté avec l'Institut Pasteur une alliance franco-russe, longtemps avant que les diplomates en aient eu l'idée."

Is it, perhaps, too fanciful to believe that the far-reaching speculations of Metchnikoff were influenced by the early impressions which he formed when as a boy he viewed with the eyes of a born naturalist the boundless steppes that surrounded his village home near Kharkoff? He can never lose his place among the company of the pioneers of experimental medicine.

Dr. B. M. Griffiths

DR. B. MILLARD GRIFFITHS, who died on March 25, was born at Kidderminster in 1887, and studied at the University of Birmingham during the years 1905–8; he took the D.Sc. degree of that University in 1923. Towards the end of the War of 1914–18 he was assistant to Prof. Yapp at Belfast, but in October of 1920 he was appointed lecturer at Newcastle and afterwards, in 1924, became reader in charge of the new botanical laboratories established at Durham, which he placed upon a secure footing.

His early work concerned the giant bacteria belonging to the genus Hillhousia and was carried out in conjunction with G. T. West, but most of his scientific investigations related to the Algæ. Already in 1912 he published a paper on the Algæ of Stanklin Pool and in 1915 a morphological study of Glaucocystis, while afterwards he turned his attention chiefly to planktonic and limnological studies. We owe to him a considerable number of data on the phytoplankton of the lowland pools of Britain contained in a number of papers published in the Linnean Society's Journal.

He took some part in the foundation of the Freshwater Biological Association and for several years represented the University of Durham on its Council. During the later years of his life he suffered much from ill-health, and this no doubt contributed materially to reduce his output of scientific work, which showed considerable promise.

F. E. FRITSCH.

NEWS and VIEWS

Grassland Research in Great Britain

Sir George Stapledon, C.B.E., F.R.S.

THE appointment of Sir George Stapledon as the director of the Ministry of Agriculture Grassland Improvement Station, Dodwell, marks a break in a long period of pioneer service which may be said to have revolutionized the current methods of grassland management. After holding the posts of professor at Cirencester and adviser in agricultural botany at Aberystwyth, Sir George became the first director of the official Seed Testing Station when it was founded by the Food Production Department of the Ministry of Agriculture during the War of 1914–18. Thence he proceeded to the chair of agricultural botany at Aberystwyth and also became director of the Welsh Plant Breeding Station when it was founded in 1919. Gathering round him a band of enthusiastic and patient research assistants, he began the long series of experiments which have made his work famous the world over.

So early as 1913 Sir George was interested in pasture problems, such as drought resistance, and the response of grassland species under manuring, and in 1916 he collaborated with his present successor T. J. Jenkin in investigations on indigenous species in relation to habitat and sown species. For the next twenty-five years his attention was devoted to the various ways in which the grasslands of Great Britain could be improved and better use made of the great acreage of unprofitable and neglected pastures up and down Great Britain. The importance of varieties and strains was fully recognized, and geneticists and plant breeders on his staff concentrated their attention on the production of the special types of the herbage plants needed for specific purposes. The labour involved was immense, and only by most skilful organization has it been possible to carry through the work without confusion or delay, and to apply the results to agricultural practice. Varieties of grasses and clovers have been bred for earliness or lateness, for leaf or stem production, for spreading or erect types, to provide seed to meet different requirements.

Parallel with the plant-breeding work, problems of management were investigated, particularly in relation to the effects of grazing, and the most amazing and valuable results were obtained. But all the time Sir George was working towards his main object of obtaining recognition from the Government and farmers alike that poor or derelict pasture could be so improved as to become an important asset instead of a liability. Much preliminary critical work was carried out, the importance of buried and viable seeds in the soil being early recognized. Then in 1933 the Station acquired Cahn Hill, whereon large-scale hill experiments could be made in order to develop methods whereby improvements could be made and to determine their economic value. Much progress has been made, both on the hill pastures and in connexion with ley farming, in which poor permanent pasture is improved by ploughing up and reseeding. Sir George Stapledon's new appointment will provide an excellent opportunity to demonstrate the value of his ideas, backed by wide experience, and the venture will be followed with great interest by all who have the interests of agriculture at heart.

Dr. T. J. Jenkin

DR. T. J. JENKIN, who succeeds Sir George Stapledon at Aberystwyth as professor of agriculture and as director of the Plant Breeding Station, has been associated with the Station from its very early days, and prior to that was adviser in agricultural botany at the University College of North Wales, Bangor. At this time he also worked on seed testing and collaborated with Sir George Stapledon. His early work at Aberystwyth included rust resistance trials with wheat, but his attention was soon concentrated on the genetics and breeding of grasses, of which work he was in charge. For years he has devoted himself to the varied aspects of grass improvement, including the problems correlated with self- and cross-fertilization in the more economic species, carrying on comprehensive experiments in connexion with the artificial hybridization of grasses. His work on inter-specific and inter-generic crosses with the grasses opens up many possibilities for the future of grassland improvement.

The valuable results obtained during the comparatively short space of a quarter of a century are eloquent of painstaking and accurate concentration on a multiplicity of details, involving great personal sacrifices of time and leisure. The appointment of Dr. Jenkin as successor to Sir George Stapledon ensures that the best traditions of the Plant Breeding Station will be carried on by one who has himself done much to build up the esteem with which the work of the Station is regarded.

Agricultural Advisers in Washington and London

THE growing importance of agriculture, both in national and in international affairs, has in recent years necessitated certain changes in diplomatic and consular representatives. Denmark, Norway, Sweden and Holland have long had agricultural councillors attached to their consulates in London; men of high distinction such as Mr. Harald Faber, Mr. van Rijn, Mr. I. Bagge (to mention only past officers) and others whose pre-eminence in their subject caused them to be greatly respected by experts in Great Britain. The United States has now appointed an agricultural adviser, Mr. Loyd V. Steere, who has already had some years of service in Berlin, so that he is thoroughly familiar not only with American but also with Continental conditions. Mr. Steere will be cordially welcomed by British agriculturists.

The British Government has now decided to appoint an agricultural expert to its Embassy at Washington and has selected Prof. Scott Watson for the post. The choice will give universal satisfaction. Prof. Scott Watson has an unusually wide knowledge of the subject and of the persons concerned with it. He holds the Sibthorpian chair of rural economy in the University of Oxford, is a member of the Agricultural Research Council and the Agricultural Improvement Council; he is also editor of the Royal Agricultural Society's publications, and is a well-known broadcaster.

Scientific Direction of War

RECENT correspondence in the Press on the direction of war strategy, to which reference is made in the leading article on p. 531 of this issue of NATURE, has had a sequel in the form of a discussion in the House of Lords on May 5. Lord Denman directed attention to the White Paper on Organization for

Joint Planning recently issued, and said there is a considerable amount of dissatisfaction among technical and engineer officers regarding methods of applying equipment to the Army. "We have men of great scientific ability, great technical experts, good factories and workshops, and skilled craftsmen and mechanics, but we need to make sure that they are being utilized to the best advantage." There should be a chain of technical responsibility from the Army Council down to the units in the field. Viscount Swinton also emphasized that we have the men of ability needed in the various fields, but found fault with the present system of utilizing them. Lord Milne said that the "great necessity at the present moment is a scheme to link together our great advantages in technical science with our requirements in military strategy".

Lord Hankey, who has until recently been much concerned with the co-ordination of resources of man-power in different fields, pointed out that the White Paper shows that great advances have been made at least in the lower stages, in the provision for collaboration, but there is room for further improvement, particularly at the ministerial stage. He expressed the hope that it would be possible to add a scientific staff to the Joint General Staff. "Each of the Service Departments is already using scientists, and has found them of great value for operational and other purposes. It is obvious that they should also be brought into the central control of the war." This reminds one of the attitude taken by Sir Henry Tizard in his address at the annual luncheon of the Parliamentary and Science Committee (see NATURE, Feb. 7, p. 164). He divided the scientific effort in relation to the War into two portions: the tactical and the strategical. With regard to the former, he said that in Great Britain we have nothing to fear from any nation; but the latter is not nearly so sound. The remedy, he said, is "to have scientists working side by side and in the closest collaboration with those who have the administrative and executive responsibility". The weight of opinion, scientific and lay, is clearly on the side of increased participation of science in the strategy of the War.

School Medical Service in War-time

IN a Chadwick Lecture delivered on May 12, Dr. J. Alison Glover, late senior medical officer, Board of Education, discussed the school medical service in war-time. In the thirty-one years between the inauguration of the school medical service and the outbreak of the present War the service passed from ascertainment and treatment to prevention, and is entering into a fourth phase, the search for "positive health", the appreciation "that it is the legislator's task to frame a society which shall make the good life possible" and so enable every child to reach the highest degree of health and development of which he is inherently capable. These phases are well shown in the changing outlook on nutrition, from the ascertainment and treatment of malnutrition to the striving after optimum nutrition. In this period of thirty-one years, the British school-child has undergone a wonderful metamorphosis for which, though many other factors have had a share, the school medical service has been largely responsible. The school-child of 1939 was bigger, more resistant to disease, cleaner and in every way fitter to stand the strain of total war than his predecessor of 1908.

The present health of the school-child after two and a half years of war is shown to be well maintained whether it be judged by clinical assessment of nutrition, average measurements of growth, the incidence of infectious and catarrhal diseases, the incidence of neurosis or the general impression of medical men, nurses or teachers closest in touch with school-children. Much vigilance is, however, necessary. The difficulties which the service encountered from evacuation naturally differed in the reception and evacuation areas. They were increased by the constant ebb and flow of the ceaseless 'drift-back', by the interruptions of alerts, by shelter life, appropriation of schools for other purposes, and by the calling up for service with the Forces of medical men, dentists and nurses. The great development of the provision of meals and milk, the intensive campaign for immunization, the conversion of the camps provided by the National Camps Corporation into residential schools, and the great development of the provision for children under five years were also described. Despite some inevitable curtailment the service has continued to render efficient service.

The Association of Scientific Workers

THE twenty-fifth annual council meeting of the Association of Scientific Workers was held during May 2–3 at the London School of Hygiene under the chairmanship of the president, Mr. R. A. Watson Watt, F.R.S. About two hundred delegates, representing the eighty-four branches into which the membership of almost six thousand is divided, attended the Council. In his opening address Mr. Watson Watt spoke of the remarkable growth of the Association especially since its registration as a trade union, and its affiliation to the T.U.C. Referring to the Conference on "Science and the War Effort" convened by the Association in January last, he said that in spite of the success of that Conference it is necessary to persist if the criticisms made then of the misuse of science in the national effort are to result in practical action.

If any fears have been felt that the remarkable growth of the Association in the trade union field was likely to have diminished its concern to maintain the highest scientific standards, these were set at rest by a number of forceful speeches insisting that the two sides of the Association's work must proceed hand in hand, and resolutions confirming this attitude were carried by an overwhelming majority. Reports were given of the successful action taken by the Association to maintain standards of payment and working conditions in industry, and of the activities of committees dealing with science education, medical services, agriculture, and the proper use of refugee scientific workers. A report was also given of the activities of branches in the work of building up an appreciation of science and scientific method among the general public.

Academy of Sciences of the U.S.S.R.

PROF. V. KOMAROV has been re-elected president of the Academy of Sciences of the U.S.S.R.

At the concluding session of the general meeting of the Academy at Sverdlovsk on May 8, the following were elected honorary members: Prof. W. B. Cannon, George Higginson professor of physiology at Harvard Medical School; Sir Henry Dale, president of the Royal Society; Prof. J. B. S. Haldane, Weldon professor of biometry at University College, London; Prof. Ernest O. Lawrence, director of the Radiation Laboratory, University of California; and Prof. Gilbert Newton Lewis, professor of chemistry and dean of the College of Chemistry, University of California.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Problem of the Autonomy of Life

Prof. F. G. Donnan's review in Nature of April 11 of my book "Science versus Materialism" embodies a few statements about order, organization and energy which ought not to pass without a challenge. He speaks, for example, of "the potency for producing order residing in the disequilibrium between the 'hot' radiation of the sun's photosphere and the relatively cool surface of this planet". Can a scientific man really believe that the difference in temperature between two surfaces (for this is all this statement amounts to) has a potency for producing order ? The remark reads like a parody of present-day fashionable philosophies. Again, Prof. Donnan speaks of the "sun's enormous store of 'organized' energy", and one is bound to ask what his criterion of organization is, and for what reason he considers the energy in the sun to be more organized than energy elsewhere ? Later he speaks of "this disequilibrium (and consequent potency for producing order)". This remark is made with special reference to "the part played by the electro-magnetic field and electro-magnetic radiation". So Prof. Donnan really does seem to believe that disequilibrium can by itself produce order, and that electro-magnetic phenomena have special virtues and accomplishments, such as powers of organization and orderliness.

The truth is, of course, that mere difference in temperature, mere radiation, mere disequilibrium, mere electro-magnetic fields, may be described as the cause of *changes*. Such changes may be ordered if there is something to guide the particles taking part in the change, but they will not be ordered if there is nothing to provide guidance, selection, control, discrimination. When we observe order or organization we have, therefore, to seek for two combined causes: the first is the source of energy, which is usually easy to find, the second is the source of the discrimination. This presents a formidable problem in science. It does so, for example, when we seek to understand the structure of living substance. It is poor science to evade this problem as Prof. Donnan wishes to do.

The *reductio ad absurdum* of Prof. Donnan's view of the potency of temperature differences and radiation would be the assertion that a number of nuts and bolts, connecting rods, piston rings, and other machine parts, would, by nothing more than sufficiently violent kicking, become a complete motor-car, and that this would not happen by chance once in a way, but as often as similar living forms are to be found.

Reginald O. Kapp.

University College,
London.

In his extremely interesting review in Nature of April 11 of "Science versus Materialism" by Prof. Kapp, Prof. F. G. Donnan seems to be playing into the hands of the metaphysicians when he describes radiant energy as a "non-material entity". From his opening paragraph, Prof. Donnan would appear to accept as a definition of 'materialist' one who regards all phenomena, whether pertaining to living or non-living things, as solely explainable in terms of "the existing concepts and laws of physics and chemistry". Certainly his rebuke of Prof. Kapp for suggesting that a non-material something else supports the assumption of a "doubly determined" pattern of life, is consistent with such a definition.

The only logical conclusion to be drawn from the findings of modern physicists is, in my opinion, that electro-magnetic radiations are, *au fond*, just as material as atoms. Physicists used to define matter as "that which affects the senses"; light, for them, was an "imponderable". But a light-wave acts on sense-organs as truly as a sound-wave or a kick on the shin. Either an electro-magnetic wave-train is of a material nature with properties investigable only by physico-chemical means, or it is not. If, as Prof. Donnan seems to imply, light radiation is 'non-material', what concept are we to form of it ? There is only one antonym to the word 'material' that does not involve tautology, and that is 'spiritual', and to state that an entity is not of a material nature is to state that it is of a spiritual nature.

May I mention some findings of recent physicists that appear to me to militate against excluding radiations from the sphere of materiality ?

(1) The fundamentals of matter (protons and electrons) behave, according to circumstances, as waves or particles; but the fundamentals of radiations (photons) likewise have both particulate and undulatory characteristics.

(2) Energy is transferable from atoms to radiations and from radiations to atoms.

(3) Mass and radiation are mutually convertible; thus, the total mass of the separate components of an atomic nucleus is not equal to the mass of the nucleus, but to that mass *plus* the 'energy of binding'. Again, in the hot interiors of the stars matter is steadily being transmuted to electro-magnetic radiations, and, according to Millikan, there is probably occurring in inter-galactic space a complementary synthesis of radiations into matter.

(4) When an electron collides with a photon, the former moves off in one direction with changed velocity; the photon proceeds in another direction with lower energy (longer wave-length and decreased frequency) but with the same velocity. Despite the modification of each entity, the combined momenta remain constant.

(5) One piece of matter can press on another; but radiations likewise exercise pressure on matter.

(6) Atoms have weight, but so have radiations, a weight "as real", says Sir James Jeans, "as a ton of coal". Like the apple, radiations are influenced by a gravitational field, and are "attracted" by a mass of matter.

These examples, which are platitudes to Prof. Donnan, are only brought forward to support my contention that an 'immaterial' entity cannot act upon, or be acted upon by, a 'material' entity, and neither can be begotten of the other. Finally, the very expression 'immaterial entity' is surely a contradiction in terms. If it is not, some new definition of 'non-material' that side-steps 'spiritual' is required.

Charles M. Beadnell.

Hollywood,
Egham Hill,
Egham,
Surrey.

MY expression "potency for producing order" means *potential availability for the occurrence of greater order (that is, decrease of entropy) in another system.* It is no part of my business to enlighten Prof. Kapp on the principles of physical science, but I may perhaps help him by quoting a passage from the writings of a world-famous physicist[1]. "In individual sections of the universe, or in definite material systems, the movement may well be towards a higher degree of order, which is made possible because an adequate compensation occurs in some other systems. Now, according to what the physicist calls 'order', the heat stored up in the sun represents a fabulous provision for order, in so far as this heat has not yet been distributed equally over the whole universe (though its definite tendency is towards that dispersion), but is for the time being concentrated within a relatively small portion of space. The radiation of heat from the sun, of which a small portion reaches us, is the compensating process making possible the manifold forms of life and movement on the earth, which frequently present the features of increasing order."

I must apologize to Prof. Schrödinger for having attributed the expression "organized energy" to him. What he meant was, of course, that the "hot" sun and the "cool" earth represent a *non-equilibrium* distribution of energy, which makes possible the occurrence under suitable conditions of an increase of order (diminution of entropy) on the surface of our planet. It is, of course, quite true, as indicated by my expressions "potency", "potential availability", and Prof. Schrödinger's expressions "making possible", "made possible", that the purely general thermodynamic argument provides only a *conditio sine qua non,* that is, a necessary but not a necessary and sufficient condition. It is this gap which affords a loophole for the metaphysicians (including metaphysically minded engineers), to insert their "entelechies" and "specifications", which are obviously nothing else than words inserted into the description for the purpose of satisfying the personal wish for a mystical element of "causality".

Science, as is seen in the work of the photochemists, biochemists and physiologists, does not proceed in this manner, but endeavours to fill the gap between necessary and sufficient by patient and detailed experimental investigation. I think it would do Prof. Kapp a great deal of good if he could spend some of his spare time in the study of photochemistry and photosynthesis. He would be surprised to find that the relatively high-frequency photons which enter the green leaf do not "kick" the "nuts and bolts" about after the fashion of the mad engineer depicted in his letter. That dramatic scene provides us indeed with a very revealing picture of Prof. Kapp's conceptual "chaos". On the contrary, he would find that the available energy of the "non-equilibrium" photons is largely utilized, by means of the leaf pigments and an enzymatic system, in producing a greater degree of order, not of disorder.

Finally, let me say, as I briefly indicated in my review, that I do not wish to deny that biological science may or will require for its more highly developed autonomous description concepts, methods of thought, and mathematical techniques which are unknown (or at least very unfamiliar and unusual) in present-day physics and chemistry. It may be necessary, for example, to distinguish between the biological concept of 'organization' and the physical concept of 'order', perhaps defining the former as a capability for producing order *for an end.* Needless to say, the teleological or finalistic element in such a definition has been anathema in physical science since the days of the Renaissance and the breakaway from medieval Aristotelian scholasticism. But an autonomous description of biological phenomena amounts to the assumption that such a description will be different in some respects in type from that hitherto found suitable for physical science. If so, it will require an appropriate mathematical technique or a method of symbolic logic involving some sort of 'dimensional' extension in its system of relationships. Its system of causation will differ from the probability-distributions of modern quantum theory, perhaps by a suitable modification of the latter by means of Volterra functionals of the historical type.

I do not think that Admiral Beadnell need have any fear that my use of the adjective 'non-material', *as applied to radiation,* will be a source of any comfort to the 'metaphysicians', for, in the sense in which I used it, non-material means 'not having the same properties as matter', but at the same time something quite as real. He is quite right, however, in pointing out that this use of the adjective non-material is inconsistent with the use of the same adjective as applied to Prof. Kapp's "specification", where it means unreal, in the sense of being derived *a priori* from the dialectic of metaphysical 'idealism'.

The complementary aspects of the descriptions, namely, 'wave-like' and 'particle-like', of the behaviour of both radiation and matter in different experimental conditions were very puzzling at one time, but I think I am correct in stating that modern quantum and quantum-statistical theory has found a consistent method of predicting the macroscopic results of all such experiments without involving the assumption that matter and radiation are synonymous terms. I think that if Admiral Beadnell will refer to Heitler's recent book on the quantum theory of radiation, he will obtain a definite answer to his question such as I am not competent to give. I wish to thank him for his friendly comment and his kindly reference to my review of Prof. Kapp's book.

F. G. DONNAN.

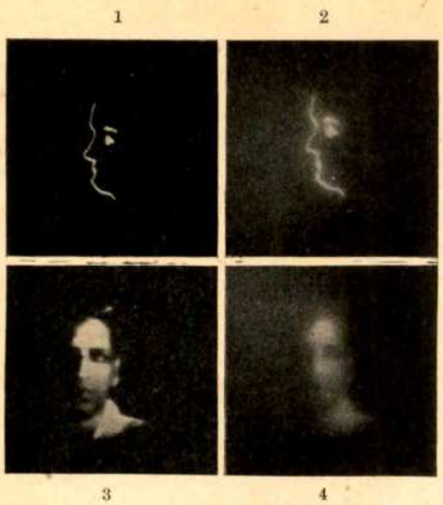
The Athenaeum,
London, S.W.1.

"Science and the Human Temperament", by E. Schrödinger. Translated by James Murphy. (London, George Allen and Unwin Ltd., 1935.) The passage quoted occurs on pp. 39 and 40.

Optical Images formed by Conical Refraction

A PLATE of biaxial crystal cut approximatel normal to the axis of single-ray velocity has th remarkable property of forming optical images o an illuminated object held in front of it. This effec was first observed with aragonite[1] but is exhibite in a much more striking fashion by a plate c naphthalene prepared for the exhibition of conica refraction as described in a recent note[2]. Th accompanying reproduction illustrates this phenomenon. 1 and 3 reproduce objects held in front of th crystal, while 2 and 4 are the corresponding image formed in the rear of the crystal and received directl on a photographic plate. The image recorded is i every case erect and of unit magnification. Th distances of the object and of the image from th crystal faces may be independently varied fro zero up to large values.

We have investigated the explanation of this effect, using a point source as the object, and find that in every case the light reaching the image-point diverges behind it in the form of a hollow cone of rays, the angle of divergence depending on the distances of the object and of the image from the crystal faces. The image formation is thus due to a kind of generalized 'external' conical refraction which can scarcely be reconciled with the ordinary ideas of geometrical optics. Our experiences show clearly that the usual explanations of conical refraction do not go deep enough into the physical aspects of the problem.



OPTICAL IMAGES FORMED BY A NAPHTHALENE CRYSTAL.

C. V. Raman.
T. M. K. Nedungadi.

Department of Physics,
Indian Institute of Science,
Bangalore.
March 5.

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[1] Raman, C. V., Nature, **107**, 747 (1921); *Phil. Mag.*, **43**, 510 (1922).

[2] Raman, C. V., *et al.*, Nature, **147**, 268 (1941).

Colour Measurement

Mr. Guild's letter[1] makes it clear that the recent conflict in views on colour measurement arises by his adopting an interpretation of the role of the C.I.E. colorimetric system which puts it outside purely physical discussion. The explanation he suggests does not, however, apply, as I have not been concerned with the public and practical aspect to which he refers. As was clearly stated[2], my remarks referred to the purely physical analysis of the phenomenon of colour, and measurement of the quantities following from such analysis: the C.I.E. system was therein referred to for what fundamentally, apart from all implication and interpretation, it actually is, namely, a conventional schematization of physical fact, having reference to certain conditions of observation, based, of course, upon averaged data but nevertheless representative in such conditions of a possible *real* observer (cf. the analogous purpose served by Listing's typical schematic eye in ophthalmology). In this sense the system forms in general a representative first-order theory. Such use of the system accords with normal physical practice, for no suggestion of compromise in form, or simplification of the phenomenon has hitherto been implied in the reduction of physical data to refer to the C.I.E. normal observer.

Mr. Guild makes no reference to this aspect of the question, but he makes it clear that, in his interpretation, the C.I.E. colorimetric system is not subject to the limitations affecting the physical theory upon which it is based and that it exists absolutely and purely by virtue of definition. A physical phenomenon can, however, only be defined by relation to the conditions in which it is observed, and the existing physical knowledge of the time: the C.I.E. quantities which Guild postulates are, therefore, in general fictitious, and the C.I.E. standard observer in this extended sense, therefore, is artificial and lacking properties relating to the important physical phenomena connected with the variation of such conditions as field size. For some practical purposes this may suffice, but the theory cannot be regarded as complete while such phenomena remain demanding explanation.

Measurement on the basis of such an interpretation is clearly not measurement of physically significant quantities, and considerations involving such an interpretation are, therefore, beyond the scope of the present discussions. My statements on the subject from the point of view of the development of colour physics remain unaffected by the statements made on such other grounds in the recent correspondence.

It is, of course, possible to maintain views on interpretation, compromise and simplification for ordinary purposes, and Mr. Guild's promised statement will be awaited with interest.

J. W. Perry.

Adam Hilger Ltd.,
98 St. Pancras Way,
London, N.W.1.

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[1] Nature, **149**, 442 (1942).

[2] Nature, **149**, 76, 247 (1942); **148**, 961 (1941).

Periodicity of Refection in the Wild Rabbit

Since my previous communication on this subject[1] various fresh data have thrown new light on the coprophagy or refection rhythm in wild rabbits. Taylor[2] reported, that of a number of wild rabbits shot and examined for the presence in the stomach of soft fæcal pellets such as are re-ingested immediately, those shot in the evening contained such pellets; those shot in the morning did not. He suggested, therefore, that the rhythm in wild rabbits was the reverse of that found in domestic rabbits; the resting period of the former being during the day, naturally this would be the time when soft or 'night' pellets are produced and swallowed.

Since then I have taken careful note of the stomach contents every time a wild rabbit, which was killed at a known hour of day, came into my hands. I have also included records in which the time of death could be narrowed down to four or five hours. Recently I was able to examine fairly extensive material from a large area of woodland in Gloucestershire and this constitutes the greater part of the data upon which the accompanying table was based.

The criterion used was simply the presence or absence of soft pellets in the stomach. In 135 of the rabbits examined a note was also kept of the contents of the rectum; in only 4 cases did it contain soft fæcal pellets, whereas in 19 cases they were found in the stomach. It is clear from this that the process of formation and evacuation of soft fæcal pellets takes a comparative short time and is evidently not a process which is going on continually during the day resting period of the wild rabbit. This is what would be expected, if, as Eden[3] maintains, the production of dry fæcal pellets goes on most of the time, interrupted at certain points by a rapid emptying of the deeper part of the cæcum and production of soft pellets.

Period (G.M.T.)	No. of rabbits examined	Per cent stomachs with pellets
21 — 2 hr.	12	33
2 — 6	62	0
6 — 11	30	86
11 — 14	17	88
14 — 16	21	86
16 — 19	9	45
19 — 21	41	5
Total ...	192	

The accompanying table summarizes data from 192 rabbits. The periods are unequal because it was difficult, when collecting field data at other people's convenience, to narrow down the time of death to within the same range of time all through the twenty-four hours. The number of stomachs containing soft pellets is expressed as a percentage of the total for each period.

It is clear that at this time of the year (March 9–12) there are two periods during the twenty-four hours when refection of fæces takes place. The main period is, as Taylor suggested, during the day from 6 a.m. until 4 p.m., though it is not quite accurate to say that soft pellets are not found during the morning: it would be more accurate to substitute "late night and early morning". From 4 until 7 p.m. the rate of occurrence falls to 45 per cent and from 7 until 9 p.m. it is only 5 per cent. This drop corresponds with the normal commencement of feeding at this season. From 9 p.m. until 2 a.m. there is a smaller peak, and then again, when late night and early morning feeding commences, there is a drop right down to 0 per cent. In practically all rabbits examined at this time the stomach was crammed with fresh food.

These data are confirmed by activity records made at an experimental rabbit warren. The area was wired round with netting: the rabbits went out to feed through gates which operated mercury switches and recorded the time. Through March feeding activity showed peaks at dusk and just before and after dawn.

The apparent discrepancy between my previous observations and the observations given by Taylor[2] is explained by the fact that the morning occurrences of refection observed by me would come just at the beginning of the large day-time peak: rabbits shot during the early morning activity period would be earlier than this. The lack of observations of evening refection is probably accounted for by the process taking place inside the warrens.

These results, of course, only apply to a season when day and night are equal. In summer, when the shorter nights give less feeding time, it is possible that the rhythm may change.

H. N. SOUTHERN.

Bureau of Animal Population,
University Museum,
Oxford.
March 31.

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[1] Southern, H. N., NATURE, **145**, 262 (1940).
[2] Taylor, E. L., *Vet. Rec.*, **52**, 259–62.
[3] Eden, A., NATURE, **145**, 628–9 (1940).

A Substitute for Glycerine as a Mounting Medium

FIFTY per cent glycerine which is widely used as a temporary mounting medium for sections of plant tissues is now difficult to get. Instead, a nearly saturated solution of calcium chloride can be tried. Put excess of commercial calcium chloride in tap water, remove the slight amount of chalk with hydrochloric acid, let any bits settle and filter if necessary. This solution is rather similar to 50 per cent glycerine in viscosity, refractive index and, of course, will not dry up. At pre-war rates it is a good deal cheaper than 50 per cent glycerine. It can be used in just the same way as glycerine with such stains as iodine, Sudan III, alcoholic phloroglucin (but not alkalis or sulphates). If the bulk of the calcium chloride is removed by washing the section in water or alcohol for a moment, it can be stained and dehydrated in the ordinary way.

T. M. HARRIS.

Botany Department,
University of Reading.
May 2.

Simplification of Musical Notation

JEANS's great work on music is difficult for the ordinary physicist, if he knows nothing of music, and for the musician, not readily understandable, if he be unsympathetic to physics. There seems a moral to be drawn from it, however, that has been missed. It is, how can we make music simpler so that more people can play, anyhow to start with, the basic instrument—the piano.

I wonder if I shall awaken a chord in the youth of many when I say I tried like others when young, but found it just too difficult, and its difficulty lies in its notation. I maintain, in that all have been taught to read thoughts from printed paper, by virtue of conjuring up sounds to the brain as speech, so it should be simple to devise a method by which we could hit the correct notes indicated on a piece of written music with the facility we do the typewriter. The reason we cannot do this is that there is a conspiracy against us to make it difficult, and it is wrapped up with sharps and flats.

I will not go into the details why *A* sharp and *B* flat are not theoretically the same note, but due to what is known as 'equal temperament', they are in fact on the piano actually the same note. What is the point of making such a fuss to discriminate between the two, when all that can be struck is the one note?

Then comes the arch-conspiracy of writing in separate keys, when nothing you see on the paper is what you think it is. Who would ever have learnt to read an ordinary book if at the start of a chapter it was announced that it was a sad story and in a minor key, whereupon most of the letters of the alphabet were changed about, and then to find in the next chapter, when things brighten up a bit, that the letters have changed again in an entirely different way. Nobody but a thought-reader could have persevered, yet so it is with music; no one but a musician goes on with it. But the ordinary man reads his book with enjoyment, though not a student: so should an ordinary man enjoy playing the piano even if he be not a musician.

The first thing I plead for is that all music be written in a straightforward honest way, as if it were in the key of *C*, with all accidentals inserted. You could at least read it. You would find out later it was not in that key, but would that matter, as you would be playing it in the key desired and what more do you want? If we could get as far as that, it would be something, but I go further. I contend there are only twelve notes in an octave on the piano. All you want to know is which of the twelve to hit and in which octave. Surely not a very difficult problem in notation.

Here is really where a little organized common sense—sometimes called science—might bring great joy to millions. Surely such a thing is worth while trying and not beneath our dignity, but do not expect help from musicians; they revel in the mysticism of their trade union.

Brabazon of Tara.

70 Pall Mall,
S.W.1.

Quality Control in Manufacture

The note in Nature of April 11, p. 408, on "Quality Control in Manufacture", repeats an error made in the article on which the note is based. Prof. R. A. Fisher has made many notable contributions to statistical theory and practice, and his elegant analysis of variance may possibly be considered the outstanding contribution of the century, but I think he would be the last to agree with the statement made in the opening phrases of the second sentence of the note. The theoretical foundations on which the control charts for averages of samples is based have been long known, and those for control charts for measures of variability have been laid by the work of British statisticians other than Prof. Fisher.

Apart from this error, I think that by not referring to the British Standards Institution publication of 1935 on this subject, the notes may leave the impression that the technique is only just receiving attention in Great Britain after many years practice in the United States. Dr. W. A. Shewhart's visit to England in 1932 focused attention on the work proceeding at that time in some British industrial organizations and stimulated interest in it. The formation of the British Standards Institution Committee in 1933, which led to the publication of B.S.S. 600 (1935) and the formation of the Industrial and Agricultural Section of the Royal Statistical Society, were some of the results of the increased interest in the subject.

The interested reader will find on close examination that the use of statistical methods has been growing simultaneously in Great Britain and the United States, and that the development has differed in detail but not in principle. A careful study of the two documents to which reference is made (B.S. 600 *R*: 1942 and B.S.1008 : 1942) will reveal this.

Bernard P. Dudding.

Research Laboratories,
General Electric Company, Ltd.,
Wembley.

Education for Culture and Citizenship

The conflict between subjective and objective biological teaching, referred to in the leading article on "Education for Culture and Citizenship"[1] and by Mr. L. J. F. Brimble[2] need not arise when the subjects of a school curriculum are more closely related, so that matters undesirable to teach from one angle can be taught from another. Such closer relationship could be obtained were education regarded as the fitting of man for his environment.

The subjects of the school curriculum would then fall into two groups: (1) man in relation to environment (the humanities), and (2) environment in relation to man (the sciences). Each group would dovetail into the other, and each subject be taught as part of a related whole, to the relief of overcrowded curricula. Environment for juniors would, of course, be the vicinity of the school, and syllabuses be based on its natural features and human activities. Even great cities provide a surprising amount of material for biological study and for that training in habits of observation and inquiry which is the root of true education. As the students get older, environment would broaden out to the whole world, and travel and research begin to play their part in education.

T. S. Dymond.

14 Albany Road,
St. Leonards-on-Sea.
April 28.

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[1] Nature, 149, 447 (April 25, 1942).

[2] Nature, 149, 457 (April 25, 1942).

First Publication of the Geological Society

In reply to Mrs. Eyles's query[1], there is no reason to doubt that the pamphlet "Geological Inquiries" was issued in 1808, which is the date inscribed by Horner on his copy now in the library of the Sedgwick Museum. That it was published before the first volume of *Transactions of the Geological Society* is clear from the following extract from the Preface (*Transactions*, 1, June 28, 1811, p. v): "shortly after their establishment [Nov. 13, 1807] they [the founders of the Geological Society] drew up and distributed a series of inquiries."

L. Hawkes.

1 Chaucer Road,
Cambridge.

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[1] Nature, 149, 442 (1942).

FLOODS OF SEPTEMBER 1938 IN NEW ENGLAND

THE hurricane which visited New England in September 1938 is rather artlessly described in a massive volume of 562 pp. as "the greatest catastrophe since settlement by the white man"*. The loss of life was very heavy and the material damage by flood, wind and wave exceeded three hundred million dollars. The greater part of the damage was caused by flooding of the rivers resulting from heavy rain, and coming so soon after the great floods of March 1936 it caused much alarm. The U.S. Geological Survey has accordingly collected all the available information about rainfall and river-levels as a basis for the design of protective measures for the future.

The antecedent conditions were unfavourable but not in themselves dangerous. In the preceding months rainfall had been above normal, and by September 11 there was an accumulated surplus of moisture in the ground. Heavy rain during September 12–16 added to this, but though the rivers ran bank high there was no flooding. On September 16 there was even some improvement, but from September 17 onwards the weather was consistently unfavourable. On September 19 a trough of low pressure lay over New England in which moist tropical air moved northwards, giving falls exceeding 5 in. in twenty-four hours. Meanwhile a tropical hurricane was moving rapidly northwards near the coast. As a rule these hurricanes keep well to the east, but this one was diverted into the open trough of low pressure, and on September 21 moved rapidly inland towards the Canadian border. On the eastern side of the centre the winds reached hurricane force, doing widespread damage, and the rainfall was torrential, but with the passage of the centre the rain ceased abruptly. In the twenty-four hours ending at 6 p.m. on September 21, 6 in. or more fell over 1,020 square miles, and floods which, though severe, might have been manageable, burst all bounds.

Rainfall charts are given day by day and again for every twelve hours, but since the effect of flood rains is largely cumulative, greatest interest centres in the map for the whole period September 17–21. The distribution is remarkable, for while there was a rainfall of 6–10 in. in these five days over a very wide area, the greatest amounts of 10 in. to more than 17 in. were confined to a comparatively narrow belt along the hurricane track northwards from Long Island, comprised mainly within the basins of the Connecticut, Merrimack and Thames Rivers. Over an area of 100 square miles in Connecticut and central Massachusetts the rainfall exceeded 16 in., equivalent to the total average rainfall in London from January to September inclusive. On the eastern side of this belt the rainfall diminished almost abruptly, so that the coast of Massachusetts received only a few inches, but on the western side the decrease was more gradual and flooding extended for some distance with decreasing severity. In many places on the smaller streams in the central belt the crest of the flood reached levels several feet higher than any previously recorded. The tables of flood height and discharge which make up a great part of the book show instances of discharges which were only a few cubic feet per second per square mile of drainage area on September 18 and 100 cub. ft. on the morning of September 21, but had risen to 400 or 500 cub. ft. a few hours later. On the larger rivers the rise was naturally slower as various tributaries came in at different stages, but the cumulative effect was as great. Under the pressure of the water, dams and bridges gave way and the rivers spread over their flood plains, destroying roads, railways and houses; the damage is vividly shown by a fine series of photographs.

The coasts naturally did not suffer from river flooding, but they were swept by a great storm wave, which in the eastern areas coincided with the normal time of high tide and rose to heights of 10 ft. and, where the waters were heaped up in narrow channels, more than 17 ft. above the average level of high water; New York's holiday coast was devastated, scores of houses being completely demolished.

The flood problem of rivers in populous country is one of great complexity. To enable the waters to flow away freely and naturally, the flood plain should be kept unobstructed, but the life of the towns and villages depends on the river, and encroachments are hard to avoid, while it is to these low-lying settlements that the danger is greatest. Reservoirs, whether constructed specially for the purpose of controlling flood water or for other purposes, play a useful part in minimizing the rise, but if the river sweeps away the obstructing barrier and empties the reservoir, the sudden influx of stored water may add to the catastrophe; in fact, many of the curves of flood height show a double crest due to this cause. The volume of flood water depends on the absorption of the ground as well as on the rainfall; the great flood of March 1936 was magnified by the melting of the snow and by the imperviousness of the ground, which threw practically the whole of the rain-water into the rivers; by contrast in September 1938 the ground, in spite of its previous soaking, managed to absorb a good deal of the earlier rainfall, though it could not cope with the torrential downpour of the last day.

Hurricanes have visited New England before, and will doubtless do so again, but this detailed record compiled by the U.S. Geological Survey will at least provide American engineers with the data for plans to minimize, though they are unlikely to be able entirely to avert, the effects of future visitations.

C. E. P. Brooks.

BIOGEOGRAPHIC DIVISION OF THE INDO-AUSTRALIAN ARCHIPELAGO

ON April 16 and 30 a discussion was held by the Linnean Society under the chairmanship of the president, Dr. E. S. Russell, on "the biogeographic division of the Indo-Australian Archipelago, with criticism of the Wallace and Weber lines and of any other dividing lines, and with an attempt to obtain uniformity in the names used for the divisions". The following papers were contributed: Mr. J. B. Scrivenor, "Geological and climatic factors affecting the distribution of life in the Indo-Australian Archipelago"; Mr. I. H. Burkill, "A historic account of the divisions which have been proposed"; Dr.

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* Hurricane Floods of September 1938. U.S. Geological Survey Water-Supply Paper 867, 1940.

Malcolm A. Smith, "The divisions as indicated by Vertebrata"; Dr. A. S. Corbet, "The divisions as indicated by the Insecta"; Mr. H. K. Airy Shaw, "Some general considerations from the botanic standpoint"; Dr. P. W. Richards, "On the ecological segregation of the Indo-Malayan and Australian elements in the vegetation of Borneo"; Dr. F. E. Zeuner, "The divisions as indicated by the distribution of insects in relation to geology".

The object of the discussion, in so far as it aimed at uniformity in principle, can be said to have been attained because there was a general opinion that division into biogeographical sub-regions was preferable to divisions by lines such as the Wallace and Weber lines, but no agreement was reached as to what those sub-regions should be. At the same time it was held that the Wallace and Weber lines retained some importance, but that the Wallace line as drawn by him to pass from the northern end of the Macassar Strait to the east of the Philippines should be modified so as to pass along the deep channel between Mindoro and the small islands off the northern end of Palawan. The southern termination of the Wallace line between Bali and Lombok has been criticized as unimportant by Dutch zoologists, none of whom, through the unfortunate force of existing circumstances, could take part in the discussion. It was also agreed that at the height of the Pleistocene glaciation the Sunda and Sahul shelves were dry land but that there is no precise knowledge yet how far the sea rose above its present level when the ice melted. The discussion was partly directed to considering the validity of Wegener's theory of continental drift as applied to the particular hypothesis that the Australian continental block with New Guinea as a spear-head has broken through what was once a continuous chain of islands now represented by the islands of the Banda Arc and the Bismarck Archipelago. An inquiry as to the general opinion of geologists about continental drift elicited a reply that the theory explains so much that there is a feeling that it must be true but that as yet there is nothing that can be called proof of it. It was agreed that the Indo-Australian Archipelago consists of two comparatively stable areas, the Sunda and Sahul shelves, with a very unstable area, sometimes called 'Wallacea' in between, where mountain-building is now in progress and where islands with rugged contours alternate with areas of deep sea. The Wallace line roughly follows the edge of the Sunda shelf and the Weber line that of the Sahul shelf; but the latter is drawn so as to pass on the west of the Kai Islands and on the west of Halmahera, whereas the edge of the Sahul shelf is to the east of those islands.

Mr. Burkill gave an interesting survey of proposed zoological and botanical divisions, the former following vertical and the latter horizontal lines. He mentioned doubts expressed by Wallace himself about his line and especially about the position of Celebes with regard to it, which he said ("Island Life", 1895 ed., p. 462) might perhaps with equal propriety be left out of both the Oriental and Australian regions. Weber's line was the result of tudying the distribution of freshwater fish, but had been slightly modified by Pelseneer and Merrill, while Lydekker would have placed Halmahera west f it.

The unstable 'Wallacea' is a broad transition belt n which a mixture of fauna and flora occurs. Dr. Malcolm Smith emphasized the evidence given by the re-establishment of life on Krakatau after the 883 eruption of the ease with which organisms, large and small, could have travelled by water and air from the continental areas to the islands in this belt. He said that while the Sunda vertebrate fauna is very like that of Asia, that of New Guinea is not so similar to that of Australia because climatic and geographical conditions differ to a greater extent.

Mr. Airy Shaw said that lowland and mountain floras in the Indo-Australian Archipelago may have quite different affinities with the floras of adjacent regions. Speaking of the floras within the Archipelago, he said that the lowland floras of Sumatra, the Malay Peninsula, Borneo and the Philippines are much the same, but that of Java differs from them. The mountain floras of Sumatra, Java and the Lesser Sunda Islands resemble each other but differ from the mountain flora of Borneo. Dr. Richards, as a result of his work in Borneo, thought that the Australian element has only been able to penetrate into the Archipelago where the soil is poor, and he thought that the Wallace line only holds good at all in so far as it agrees with the divisions of climatic and physical factors.

Dr. Corbet and Dr. Zeuner both dwelt on the importance of butterflies in connexion with the discussion and described the distribution of certain genera. The former proposed a division into sub-regions which he named the Malaysian, the Philippine, the Celebes, the Moluccas and New Guinea, and the Lesser Sunda Islands sub-regions. These differed from Dr. Malcolm Smith's proposal of Malaysian, Philippine, Indo-Chinese, Papuan, Austro-oriental and Australian sub-regions. Dr. Zeuner thought that the Wallace and Weber lines could not be defined biologically and that the Australian continental block is approaching Asia.

In a general discussion which followed the last paper read, Mr. Norman cited the evidence of the distribution of freshwater eels as bearing on the earlier relations of land and sea in this area. The importance of co-operation between biologists and geologists was mentioned, but one speaker pointed out that neither must rely on the other too much for proof of their theories but must rely chiefly on their own efforts.

J. B. Scrivenor.

CARNEGIE INSTITUTION OF WASHINGTON

The Year Book of the Carnegie Institution of Washington No. 40 covers the year July 1, 1940–June 30, 1941, and includes the report of the president as well as the reports of departmental activities and co-operative studies.

In his report, the president refers to the retarding of the attack on many problems on the border line between physics and biology, to implement which the construction of a large cyclotron has commenced, as well as on the new approach to human genetics, but emphasizes the responsibility of such an organization as the Carnegie Institution for preserving intact some of the more important threads of fundamental scientific research, now almost completely stopped all over the world. With regard to defence activities, nearly all the research in the Department of Terrestrial Magnetism was on Government problems, and the number of men employed in that laboratory had been more than doubled. Important work was also proceeding in the Geophysical Laboratory, the Mount Wilson Observatory and the Nutrition Laboratory.

To secure the proper integration of the combined research effort in the United States, Mr. Roosevelt has created the Office of Scientific Research and Development as a part of the Office for Emergency Management, and the president of the Carnegie Institution is the director of this Office, and many of the staff are members of its organization. The president points out that the close connexion of the Institution with the defence research effort has led to much closer contact between members of its staff and outstanding scientific men of the country, which should be of great benefit when the full normal programme is renewed.

Despite the preoccupation of most of the staff of the Department of Terrestrial Magnetism with defence research, progress has been made with its fundamental programme, and it is anticipated that the cyclotron will shortly be completed. The studies of the electrical and chemical conditions of the air at great heights are also progressing, as well as the co-ordination of magnetic, solar and upper air studies relating particularly to problems of radio transmission. Further progress in studies on photosynthesis is reported from the Division of Plant Biology, where recent research relating to the chemical mechanism of the photosynthetic process has necessitated revision of the old hypotheses in regard to the chemical interaction involved.

In the development of co-operation between the Department of Genetics and the Long Island Biological Association, a symposium at Cold Spring Harbor on the subject of the gene and the chromosome attracted a large group of scientific workers. Plans for the continuation of such co-operation are being formulated.

In the Nutrition Laboratory progress has been made in the development of instrumental technique and in co-operative studies of carbohydrate metabolism with reference to diabetes.

Interesting results have been obtained in the Geophysical Laboratory with the equipment for studying silicate minerals in the presence of water at high temperatures and pressures, such as prevail deep within the earth. The apparatus used is essentially an electric furnace within a strong closed chamber in which materials can be exposed to the action of steam at pressures of several thousand pounds and at temperatures far above a red heat. Other work has been concerned with the properties of solutions under high pressures.

FORTHCOMING EVENTS

Monday, May 18

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Sir Henry Craw: "The Burma Road".

Tuesday, May 19

Iron and Steel Institute (joint meeting with the Sheffield Society of Engineers and Metallurgists, the Sheffield Metallurgical Association and the Refractories Association of Great Britain) (at the Royal Victoria Station Hotel, Sheffield), at 5.30 p.m.—Discussion on "Open-Hearth Furnace Refractories": (*a*) "Dolomite Bricks", (*b*) "Open-Hearth Roofs, including Temperature Control". (Chairman: Dr. W. H. Hatfield, F.R.S.)

Wednesday, May 20

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. H. D. Kay: "The Future of the Milk Industry".

Institute of Physics (Electronics Group) (at the Royal Institution, 21 Albemarle Street, London, W.1), at 2.30 p.m.—Discussion on "Amplifiers for Measurement and Control" (to be opened by Mr. C. A. A. Wass).

Royal Meteorological Society (joint meeting with the Physical Society) (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Discussion on "Emission and Absorption of Radiation in the Atmosphere" (to be opened by Dr. T. G. Cowling).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Junior Assistant (male or female) to the Public Analyst—The Public Analyst, Parker Lane, Burnley (May 20).

Headmaster of the Eastbourne Technical School—The Education Officer, Technical Institute, Eastbourne (May 23).

Assistant Lecturer in Agricultural Bacteriology—The Registrar, The University, Leeds 2 (May 29).

University Chair of Biochemistry tenable at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (June 8).

Instructor in Electrical Engineering at the East Ham Technical College—The Secretary for Education, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6.

Senior Laboratory Assistant—Mr. R. W. Stott, Rugby School Science Laboratory, Barby Road, Rugby.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

John Innes Horticultural Institution. Thirty-second Annual Report for the Year 1941. Pp. 14. (London: John Innes Horticultural Institution.) [274

Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 10, 1941. Pp. vii+127+29 plates (London: Brompton Hospital.) 5*s*. [284

Carnegie United Kingdom Trust. Twenty-eighth Annual Report 1941. Pp. 16. (Dunfermline: Carnegie United Kingdom Trust.) [284

Other Countries

U.S. Department of Agriculture. Miscellaneous Publication No 439: The Fruitflies of the Genus Anastrepha. By Alan Stone. Pp 112+23 plates. (Washington, D.C.: Government Printing Office. 40 cents. [224

Imperial Council of Agricultural Research. Miscellaneous Bulleti No. 54: A Further Survey of some Important Breeds of Cattle anc Buffaloes in India. By F. Ware. Pp. iii+16+21 plates. (Delhi Manager of Publications.) 1.4 rupees; 2*s*. [224

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No 10 (Utilisation): A Preliminary Note on the Use of Prolamins a Adhesives. By D. Narayanamurti and V. Ranganathan. Pp. ii+4 (Dehra Dun: Forest Research Institute.) [23

Indian Forest Records (New Series). Botany, Vol. 3, No. 1: Th Flora of the Aka Hills. By Dr. K. Biswas. Pp. 62. 2.2 rupees; 6*s*. 6*d* Botany, Vol. 3, No. 4: A Short Account of the Geology and Flora o the Hill Zamindaries in Kalahandi State. By H. F. Mooney. Pp 131–143+4 plates. 14 annas; 1*s*. 3*d*. Botany, Vol. 3, No. 5: Nev Indian and Burmese Species. By Dr. N. L. Bor. Pp. 144–150+ plates. 10 annas; 1*s*. Entomology, Vol. 4, No. 2: A Guide to th Control of Termites for Forest Officers. By C. F. C. Beeson. Pp. 44–9 1.2 rupees; 1*s*. 9*d*. (Delhi: Manager of Publications.) [23

Forest Bulletin No. 94: Specification for the Inspection and Passin of Helves and Hammer Handles. By V. D. Limaye. Pp. ii+7. annas; 1*s*. 3*d*. Forest Bulletin No. 95: Stacking Timber for A Seasoning. By M. A. Rehman. Pp. ii+9+1 plate. 3 annas; 4*d* Forest Bulletin No. 96: Drying of Wood Fuel of *Shorea robusta* (*Sal* *Eugenia jambolana* (*Jaman*), *Machilus duthiei* (*Kaula*). By M. A Rehman. Pp. ii+8+1 plate. 4 annas; 5*d*. Forest Bulletin No. 97 Experiments on the Air-seasoning and Notes on the Passing of S Sleepers. By M. A. Rehman. Pp. iv+25. 7 annas; 8*d*. Fore Bulletin No. 99: Properties, Preparation and Testing of Helve an Tool Handle Timbers. By V. D. Limaye. Pp. ii+13+3 plates. annas; 9*d*. (Delhi: Manager of Publications.) [23

U.S. Department of Agriculture. Circular No. 626: Control of th Locust Borer. By Ralph C. Hall. Pp. 20. (Washington, D.C.: Gover ment Printing Office.) 5 cents. [23

Report and Accounts of the National Botanic Gardens of Sout Africa, Kirstenbosch, Newlands, Cape (and the Karoo Garden, Whit hill, near Matjesfontein) for the Year ending 31st December 194 Pp. 12. (Kirstenbosch: National Botanic Gardens of Sout Africa.) [24

U.S. Office of Education: Federal Security Agency. Bulletin 194 No. 2: Education of Teachers; Selected Bibliography, October 1935, to January 1, 1941. By Benjamin W. Frazier. Pp. vi+6 10 cents. Bulletin 1941, No. 10: Inter-American Friendship throug the Schools. By Prof. Verna A. Carley. Pp. vi+61. 15 cent (Washington, D.C.: Government Printing Office.) [24

Pennsylvania State College: School of Agriculture, Agricultur Experiment Station. Bulletin 415: The Minimum Base Value Heat Production in Animals; a Research in the Energy Metabolis of Cattle. Pp. 26. (State College, Pa.: Pennsylvania Stat College.) [24

Bell Telephone Laboratories: a Bell System Company. Pp. 3 (New York: Bell Telephone Laboratories, Inc.) [2

NATURE

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LABOUR AND MANAGEMENT IN RECONSTRUCTION

THE Labour Party has shown both imagination and vision in the interim report on reconstruction problems in war-time issued early in March under the title "The Old World and the New Society"* for discussion at a series of regional conferences and at the annual conference of the Labour Party being held at Whitsuntide. It seems to have grasped the relation of reconstruction to the war effort and puts the point as forcibly as it has been put by Sir Stafford Cripps, and in a brilliant introductory note to a recent P E P broadsheet on bodies in Great Britain considering reconstruction problems. In detail and in broad outlook, the report is evidence that the Labour Party is facing up to the problems of the post-war world, and the whole spirit of the report justifies the hope that an attack on the problems of post-war reconstruction may be possible on non-party lines.

Any such prospect is sure of the attention of scientific workers if only for the wider possibilities it would offer of utilizing their services in the solution of such problems and the establishment of the four freedoms. Their interest in the present report is already claimed by its reference to the importance of research and to the need for a more creative attitude on the part both of Government and of industry to science and scientific research. The report calls for the conscious and deliberate endowment of scientific research, both pure and applied, the financial responsibility for which shall be shared by industry and the State. There is no field of economic life in which the possibilities of scientific advance are not immense. Many of them are arrested or withheld from enjoyment by the motives inherent in a profit-making society, and while it may take time to liberate such potentialities from the present restricting forces, the necessary endowment of scientific research should not be jeopardized.

In the same vein, the report directs attention to the need to apply in the work of reconstruction some of the important lessons of management and industrial welfare that have been learned or reinforced during the War. The widespread failure to apply the knowledge acquired by the Industrial Health Research Board and its predecessor twenty or more years ago has been profoundly discouraging to many scientific workers. Their support should be assured for any move to secure the fuller utilization of the experience which is now being accumulated on such matters as communal feeding in factories, the organization of medical inspection and care as a normal function of management, the evolution of factory discipline based on consultation and co-operation rather than on coercion, the full use of industrial psychology in testing fitness for the job, the selection for executive posts in terms of tested competence and the proper planning of factory accommodation.

The importance of wise management, utilizing the scientific techniques which are now at its disposal as well as the increasing store of factual knowledge as a basis for policy and decisions, in reconstruction as well as in furthering the war effort, is not easily overstressed. It is one indispensable factor in removing friction and misunderstanding between management and worker and developing the spirit and practice of co-operation upon which efficiency depends. The seventh and eighth reports of the Select Committee on National Expenditure afford sufficient evidence on this point, and they show also that co-operation involves a contribution from the workers themselves. A new outlook and an unprejudiced and forward-looking mind are demanded of labour as well as of management in order that the national effort for winning the war and building the peace may attain its full power and efficiency.

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* The Old War and the New Society: a Report on the Problems of War and Peace Reconstruction. Pp. 32. (London: The Labour Party, 1942.) 3*d*.

The hope that full co-operation between management and labour may yet be achieved and that the problems of post-war reconstruction may be approached untrammelled by the prejudices of party politics is encouraged by the views expressed almost sumultaneously by Mr. Bevin and Mr. Samuel Courtauld. Referring particularly to problems of demobilization after the War, Mr. Bevin stressed the importance of closer co-operation between workers and employers and the inevitability of greater State control. The fatal error would be to allow the desire for quick profits or the disposition towards rapid and undue expansion to distort post-war development into a disastrous boom. The controls which have apportioned resources in war economy must be maintained in order to distribute those resources in the most beneficial manner after the War ends. There must be a great national discipline as keen and efficiently imposed as that which has grown up during hostilities, until the problems of re-settlement have been worked out.

Clearly Mr. Bevin is prepared to face the unpopularity which may accompany the attempt to guide the nation along a difficult path which promises permanent recovery rather than a temporary boom. The twitterings which Sir William Beveridge's stimulating article in *The Times* has caused in the strongholds of individualism and *laissez-faire* are token of the opposition that will be forthcoming from the recalcitrant and backward-looking minority who find their private interests threatened. Mr. Samuel Courtauld's article in the *Economic Journal* of April shows, however, that there are leaders in industry as in science who are facing the future with unprejudiced and receptive minds.

Mr. Courtauld's article makes particularly interesting reading in the light of the Labour Party's report. Much of the ground covered is common, though the Labour Party's report includes colonial and international affairs in its survey. Mr. Courtauld, on the other hand, states the questions rather than gives the answers, and if he seems tentative, he is free from the flavour of dogmatism which at times creeps into the Labour Party's report.

When we have reached agreement as to the questions to be asked, we are entitled to expect some measure of co-operation in the search for the answers, and there is a striking resemblance in this respect in the programme outlined by Mr. Courtauld and by the Labour Party's report, and also by Prof. Carr in his chapter on "Britain at Home" in his recent book, "Conditions of Peace". Mr. Courtauld believes that the time is ripe for a review of the principles and bases of industry, and he points to the acceptance by industrialists to-day of the inevitableness of change, to their conscious respect for British ideals and the progressive gains of the past in which all classes have had a hand. There is also a re-awakening of conscience: an industrial career is now a *métier*, not merely a road to private acquisition. Fourthly, he notes a growth of real fellow-feeling with the lower ranks of industry, who have come to share the sensibilities and aspirations of those placed above them.

For all this, the leaders of industry are not likely to be stampeded into throwing everything overboard, for they have a firm faith in many enduring principles without which there is no possibility of sound rebuilding. There are many passages in the Labour Party's report which indicate at least some appreciation of this position, and it would be true to say that most, if not all, of Mr. Courtauld's assumptions are implicit in its own argument. Mr. Courtauld assumes, for example, that production is the most vital activity of the nation and that Government control has come to stay. No Government, he says, can tolerate the existence within its borders of an organized and completely independent power with a radius of action as wide as its own, and the same overriding principle that makes it the duty of the Government to control industrial combination applies to trade unions as developed to-day. Government bureaucracy, he holds, as it exists in Great Britain, has proved itself incapable of conducting business efficiently; it would require drastic reform to enable it to take any part in the running of business.

Mr. Courtauld assumes that labour will increasingly share in the management policy and rewards of industry and that the trade unions will long continue to represent labour. Gambling in industrial counters is a malignant disease for industry itself. The English genius for social evolution and for compromise can find a middle way between pure individualism and pure socialism which will bring the greatest attainable good to the nation and leave more and more vested interests out in the cold. Furthermore, he draws a distinction between productive industry and financial institutions which many scientific workers have voiced before, and his views on advertising and patent law as well as on financial institutions are tolerably certain to be the subject of lively debate.

We might well hope that these fundamental assumptions are sufficiently shared by the labour side of industry to induce a common approach to the broad questions bearing on the relations of Government and industry which Mr. Courtauld puts without always suggesting an answer. Fixed policy and the choice between free trade and protection, with the allied question of subsidies; Government ownership and control and the method of exercising control with the relation between industrial representation and the Government; the rights of labour, with such allied questions as their voice in control and management, family allowances, security and wages; industrial planning, both geographical and human, including technical education; the protection of consumers; and the control of speculation—these are all broad questions on which it is for the nation, and not industry itself, to indicate in advance the main lines of the policies concerned.

On all these topics Mr. Courtauld offers pertinent comments and suggestions, as well as on the highly technical questions, similarly calling for a national lead in policy, such as the taxation of industry, limitation of profits, depreciation and research expenditure; equalization of rates; patent law; and whether selling and distribution cost too much to-day. It is true that on certain points he is somewhat nebulous. He recognizes the importance of retaining the private initiative which fosters economic progress, and at the same time wishes to make Government control in the interests of the community effective. The solution he offers, namely, the appointment of Government directors, is nevertheless scarcely adequate.

The key problem of post-war economic policy is, however, fairly raised. Industrial management must be efficient; this cannot be achieved by Civil Service formulæ, and there must be communal control. The solution may well lie first in the training and evolution of a new type of Civil Servant competent in industrial and economic affairs, and second, and more important, as Mr. Geoffrey Crowther insists, in drawing a sharp distinction between those essential industries, such as food, transport, and probably fuel, which must be managed directly under the eye of the community, and those which must be permitted to develop within the usual pattern of private enterprise but also within the pattern of a decent, civilized and democratic society.

Mr. Courtauld's article is stimulating and refreshingly free from prejudice. His observations on the planning of the human side of industry as well as its geographical aspects are welcome, and it is encouraging to find an industrial leader openly expressing the opinion that no business should be allowed to employ more juveniles than it can absorb later into the ranks of full-grown workers. The elimination of blind-alley occupations is a task that calls imperatively for the closer co-operation of Government, employers and labour. It is a matter on which scientific workers may well be expected to make their own contribution, and Mr. Courtauld's observation that care should be taken not to educate people into blind alleys is one that teachers, too, should note. The comment that colleges and technical schools pay insufficient attention to their responsibility for relating the number of pupils taught to the probable demand for them is fair, if it is true that quantitative training and recruitment imply willingness on the part of the employer to forecast and estimate his requirements.

By and large, much of Mr. Courtauld's article finds its counterpart in the Labour Party's report. Recognition of the inability of an unplanned society to maintain a reasonable standard of life for many of its citizens is common ground, as are the consequences that flow from unregulated private enterprise—the restriction of production, waste of skilled man-power and failure to use the achievements of science and technology to raise the standard of life. Implicit in both Mr. Courtauld's paper and the Labour Party report is the acceptance of the objectives stated by President Roosevelt and of the establishment of the four freedoms; indeed, the whole of the Labour Party's report shows that the party has grasped the truths outlined so ably by Prof. Carr in "Conditions of Peace", and that it recognizes the strength which a reconstructive policy will lend to the war effort. Democracy cannot develop its full power in winning the War unless we begin during its course to organize the conditions which will ensure that when victory is won the great ends of life will be effectively served for every citizen.

The right note of caution is sounded both in this report and in Mr. Courtauld's address. The first aim is to win the War, and any measures now adopted must be justified first by their contribution to victory. At the same time, unless opportunities that now present themselves of destroying rather than consolidating abuses and obstructions are used, it is useless to talk of rebuilding industry or society on better foundations.

While, however, there is much indeed in the report that indicates that the Labour Party is prepared to face questions of industrial organization and the like in a new spirit and with an open mind, one grave defect mars the report. It is common ground in almost every impartial analysis of the new society that is to be established after the War that stability will depend on stress being laid on obligations rather than on rights, on services rendered to the community rather than on benefits to be drawn from it. A social order in which the four freedoms of President Roosevelt are to be embodied in a social minimum for every citizen must have as its counterpart a standard of duties and obligations which are expected of all.

It is this note that is lacking in an otherwise admirable statement. No united attack on the problems of post-war reconstruction, no non-party approach is possible in its absence. If the emphasis falls exclusively on benefits and rights, no democratic order will be established wide enough to resist the renewed onslaught of authoritarian regimes when the present aggressors have been overthrown. The essential task is to transmute into the service of peace and the building of a new order of society, that spirit of comradeship, of unselfish and strenuous endeavour that the very preservation of democracy now demands. If in the discussions that ensue on the basis of this report this note of service and duty is firmly sounded, as the open-mindedness of the report warrants the hope, it should not be vain to look further for that united attack on the problems ahead of us, free from prejudice and party restrictions, in which the resources and skill of scientific workers among others can be fully and effectively deployed, to the lasting benefit of mankind.

SPECULATIONS IN IMMUNOLOGY

The Production of Antibodies

A Review and a Theoretical Discussion. By Dr. F. M. Burnet, with the collaboration of Mavis Freeman, A. V. Jackson, Dora Lush. (Monographs from the Walter and Eliza Hall Institute of Research in Pathology and Medicine, Melbourne, No. 1.) Pp. viii+76. (Melbourne and London: Macmillan and Co., Ltd., 1941.) 8*s*. 6*d*. net.

THE introduction of complex foreign substances of high molecular weight into the tissues of warm-blooded animals often leads to the appearance of antibodies in the blood serum. The reaction of these antibodies with the substance that stimulated their appearance—the antigen—is largely specific. Immunologists have in the main confined their attention to the specificity of combination between antigen and corresponding antibody. Analysis of natural antigens and the artificial modification of protein antigens by the addition of active chemical groups to the surface of the molecule have both proved fruitful in revealing what particular configurations in the antigenic particle determine its power to induce and to combine with specific antibody. Much less is known about the origin and structure of antibodies themselves. A single injection of antigen sometimes yields a detectable amount of antibody, but its most striking effect is to sensitize the animal in such a way that a subsequent injection induces a rapid and disproportionately large output of antibody. Upon the readiness of this 'secondary response' depends the persistence of immunity in man and animals; though all detectable protective antibody has disappeared, the antibody response of the conditioned animal to later contact with antigen is immediate and effective.

Antibodies are modified serum globulins, and it appears that antibody globulin is produced in the cells of the reticulo-endothelial system, and perhaps in lymphoid tissue. In the absence of an antigenic stimulus these cells presumably synthesize the normal globulins. We have little knowledge of the origin of the normal serum proteins, and are consequently unable to speculate very profitably about that of the modified antibody globulin. The current hypothesis is an extension of Fischer's lock-and-key analogy for the specificity of combination between an enzyme and its substrate. It supposes that the amino acids destined for synthesis into globulin are specially disposed in a cell containing antigen; they are held in a pattern determined by the nature and arrangement of the active groups on the surface of the antigenic particle, and in this pattern are incorporated into the globulin molecule, which thus bears the specific impress of the antigen.

Dr. Burnet rejects this view of the antigen as a 'template' for antibody production. Not only does the type of antibody induced by a single antigen change as immunization of the animal is prolonged, but also the animal may still synthesize antibody when it is reasonable to suppose that the injected antigen has been destroyed and the cells originally stimulated by it have been replaced by their more or less remote descendants. Moreover, the 'secondary response' is often characterized by a sharp exponential rise in the curve of antibody production, which suggests a proliferation of the antibody-forming mechanism, rather than a rapidly accelerating production from an already established set of 'templates'.

As an alternative, Dr. Burnet in the first place postulates that the serum globulins are products of self-reproducing intracellular proteinases, and represent a stage in the synthesis at which the molecule has the essential structure of the enzyme itself, and is consequently stable. In this form it is presumably turned out in the circulation; in the cell, the proteinase reproduces itself fully. A similar conception has been advanced for the multiplication of plant viruses, but there is no valid reason why it should not apply to syntheses in normal cells. In the next place, it is postulated that these proteinases, in virtue of their enzymic function, come into contact with any foreign antigens taken into the cell, and are lastingly modified by this contact. There is no synthesis of a new unit in spatial contact with the antigen (the 'template' view) but a change in the atomic structure of the proteinase that allows its effectively hydrolytic action on the foreign antigen. When the antigenic stimulus is removed, the modified proteinase continues to synthesize itself, both in the original cell and its descendants, but there is a slow reversion to the original type, and the antibody gradually disappears from the circulation. A second injection o the antigen is followed by a rapid hydrolytic action by the specifically modified proteinase, which yields products of partial hydrolysis that in turn modify th proteinase further, and so lead to progressive change in the nature of the antibody.

Speculative hypotheses of this kind serve tw useful purposes. They may direct attention to the facts they purport to co-ordinate, and they may link up the field of speculation with hitherto unrelated fields of science. Dr. Burnet's speculations serve the second purpose less happily than the first. As a example, we may consider the modification of the self-reproducing proteinase by the antigen. We may assume that the proteinase exists, and that globulin is not formed by a more complex synthetic uni which is in effect self-reproducing. But the justif cation for the type of modification postulated rests on doubtful analogies with adaptive enzymes, an with the training of a bacterial culture to utiliz substances that are not normal participants in its metabolism. The adaptive enzyme, that become evident when bacterial cells are brought into contac with its corresponding substrate, bears a superficia resemblance to antibody in that it is specifically called into being by the substance on which it act but there is little evidence to support Dr. Burnet suggestion that it represents a modification of a existing constitutive enzyme. So far as is known, bacterial species possesses a finite range of adaptiv enzymes, and though peculiar conditions are require for their synthesis, they characterize the species a surely as the constitutive enzymes.

The analogy with trained bacteria is even mor remote. We are dealing here with an adaptatio that in many cases may fairly be considered as th restoration of synthetic powers lost in the evolutio of a bacterial species from an autotroph to a heter troph, and not a calling forth of a new and abnorma activity, for there is ample evidence to suggest th heterotrophs may retain synthetic powers which a not ordinarily manifest because they are quan tatively insufficient for the full needs of the organism

The review is wide, and includes original work b the author and his colleagues, particularly on th formation of antibodies in lymph nodes, and on th logarithmic phase of the secondary response. I Burnet's fondness for the pursuit of remote an sometimes misleading analogies may be overlooked, for his speculations, backed by the experimental facts that he has marshalled, will admirably serve the purpose of challenging immunologists to explain those aspects of antibody formation that are inadequately covered by current hypotheses.

A. A. Miles.

LOGICAL FOUNDATIONS OF PSYCHO-ANALYSIS

Psychoanalytical Method and the Doctrine of Freud

By Dr. Roland Dalbiez. Vol. 1 : Exposition. Transated from the French by T. F. Lindsay. Pp. xvi+ 415. Vol. 2 : Discussion. Translated from the French by T. F. Lindsay. Pp. xii+331. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1941.) 40*s*. net.

IT is fitting that a critical survey of Freud's writings should appear at this time. Insistent questions are provoked by the War. We witness the spectacle of a civilized people reduced to barbarism within a ew years and wonder how this is possible. Are wars, it is often asked, simply the outcome of unconscious aggressive impulses ? How deep is the mpress that civilized living makes upon the psyche ? Are humane dispositions wholly part of ontogenesis, and can no such dispositions be transmitted genetically ? To what extent can re-education in the postwar world nullify the effects of totalitarian propaganda instilled during the impressionable years of outh, and what are the limits of variation in conduct hat the same individuals may express under diverse onditions ? No satisfactory answer to these and other urgent questions can be attempted without enlisting the aid of psycho-analysis. Indeed, it is probably true to say that without psycho-analysis, ontemporary social behaviour is unintelligible and o coherent picture of human failings and aspirations ı the modern world can be drawn without invoking ts theories, provisional though they may be.

The foundations of psycho-analysis still lie in the writings of Freud. The reader of Dr. Dalbiez's work hould therefore be led to the conclusion that the task f disentangling Freud's analytic technique from the heory with which it is interwoven and of subjecting oth technique and theory to close examination were well worth undertaking, and that Dr. Dalbiez has cquitted himself with rare competence. He brings ɔ psycho-analysis a standard of logical demonstraion that has long been painfully lacking in this field. everal chapters, particularly the one entitled "The Various Neuroses", are noteworthy for their qualities f lucid exposition.

A specially useful contribution is the systematic ttempt to relate the work of Freud to that of Pavlov. This effort to unify two independent hypoheses formulated in very different terms meets with large measure of success. Even the much-disputed Œdipus conflict is readily translated into the language f reflexology, and is shown to result from a clash etween the processes of excitation and inhibition, he genital reflex mechanisms failing to differentiate etween two similar stimuli. Dr. Dalbiez maintains hat the development of the sexual impulse reveals tself in a progressive differentiation of object. This iew is presented as more in accordance with the acts than is the Freudian notion of sexual development as a succession of perverse phases culminating in normal heterosexuality. The belief that sexual development proceeds by integration of separate responses is in line with recent experiments on aggressive impulses in certain animal species.

Mention should be made of the discussion on symbolism, which clears up many confusions in the literature. In particular, the retrospective, reductive, causal interpretation of symbolism which is adopted by Freud is contrasted with the prospective, synthetic, teleological view of Silberer.

A number of criticisms rise to mind. The size of the second volume could have been much reduced ; its matter is scarcely commensurate with its bulk. One may blame the philosophic training of the author for a number of purely academic discussions. The chapter dealing with the psychoses in the first volume can scarcely be regarded as having achieved its aim. About a third of this chapter is devoted to a criticism of Dr. de Clérambault's theories of mental automatism, an allocation of space which is surely unmerited. It is disappointing to find that aggressive behaviour is not accorded due recognition. The word 'aggression' does not even appear in the index. The world of Dr. Dalbiez seems to be the peaceful world of the philosopher, and one would gather that Freud attached little or no importance to aggressive impulses—a deduction which would be very misleading.

John Cohen.

MATERIALS AND STRUCTURES

Materials and Structures

By D. A. R. Clark. Pp. xii+384. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1941.) 25*s*. net.

Practical Design of Simple Steel Structures

By Dr. David S. Stewart. Vol. 1 : Shop Practice, Riveted Connections and Beams, etc. ; a Text-Book suitable for Civil Engineers, Structural Engineers, Road and Railway Engineers, and Students at Universities and Technical Colleges. Second revised and enlarged edition. Pp. xv+184. (London : Constable and Co., Ltd., 1941.) 14*s*. net.

THE first of these two books has been written to meet the needs of students preparing for examinations in strength of materials and structures such as those in Part I of the University of London degree, Higher National Certificate and engineering institutions' syllabuses. These demand knowledge of the calculus, and the book assumes a similar standard. It is therefore disconcerting to find several pages given up to the working out in detail of the formulæ for the moments of inertia of such simple sections as form the most elementary exercises in integration. If the reader requires to be shown the detailed operations in the case of these geometrical sections, by how much the more must he need some light on the methods by which practical sections can be evaluated. From this point of view the author has not gone far enough to satisfy the needs of students at the stage indicated.

The pattern of the book is determined by its devotion to the subject of structures, and this gives it a distinct character. Instead of ranging over the aspects of strength of materials which appertain to machines, it confines itself to those concerned with structures and its examples are drawn from this branch of engineering. It is therefore to the structural engineering student in particular that it will appeal and whom it will most greatly help. He will find it a valuable medium of preparation for his profession as well as for the more immediate needs of examinations.

Following a very able presentation of the behaviour of materials under stress, there is a useful chapter on the production of metals and on the various treatments by which steel, in particular, can be improved or developed in certain desired directions. Besides familiarizing the student with the metals, this will assist him in understanding their specifications. A lengthy chapter on testing contains much information regarding the recognized tests and test-pieces, and describes various testing machines and appliances, the text being supplemented by diagrammatic sketches illustrating their principles. The latter part of the book is devoted to structures, and treats of framed structures, influence lines, deflections, suspension chains and bridges, and finally masonry. As a concise and educative statement of the theory of structures, this section can be confidently recommended to the student to whom the subject is as yet unfamiliar.

In contrast to the volume just described, Dr. Stewart's book deals with the practical design of some of the more simple structural details. In its earlier chapters it provides information regarding the rolled sections used, drawing office practice and procedure in relation to estimates and tenders, specifications and the ordering of material—all extremely useful information to the uninitiated. Equally so is the description of the template loft, the works and the machines and processes which are to be seen there.

The designs which are dealt with in this first volume of the series are of simple riveted fastenings and splices for various purposes and of beams. The complete design of a 20-ft. span gantry girder forms the tail-piece. As compared with the earlier edition, several new features have been introduced in the form of amendments to bring the text into line with the latest specifications, fresh material has been added, and an innovation is made in the arrangement of the text on the final design so that the calculations and explanatory notes are kept apart on opposite pages, thus giving a greatly improved presentation of the subject in its two aspects, instruction and example.

WORK OF PIERRE DUHEM

The Methodology of Pierre Duhem

By Armand Lowinger. Pp. ix+184. (New York: Columbia University Press; London: Oxford University Press, 1941.) 15*s.* 6*d.* net.

IN a prefatory note the author states that his aim is to provide a summary in English of the work of Prof. Pierre Duhem (1861–1916) on scientific methodology. The greater part of the book consists of extracts from his papers and from his book "La Théorie Physique", published in 1906 and 1914, with connecting passages supplied by the author. In the last chapter the author offers some criticisms.

It is rather difficult to assess the value of a book published in these conditions. At the present time there is little in it that is not familiar to workers in the subject, many of whom will emphatically accept it and others equally emphatically reject a great deal of it; to them the only question will be whether Duhem anticipated work that has been generally attributed to others. It does not appear to me that he did. His approach is substantially that of Mach, except that he does not wholly reject metaphysics; he only draws a line distinguishing it from science. But this distinction involves the rejection of "models" and explanations from science; he insists on abstract formalism. I should say that the latter is very good if it can be done, but before accepting it as a general principle I should like to see the facts of geophysics represented without the aid of the model that we call 'the Earth'. He accepts Mach's view that the whole aim of scientific theories is economy of statement. He agrees that we make inferences from them beyond the original data, and expect the results to be verified, but says that this has no logical justification and is not science. I should say, so much the worse for such a narrow logic.

There is no mention in the book of Karl Pearson's "Grammar of Science", published in 1892, which does face this problem; and I consider that any later work on methodology that omits reference to the "Grammar" is like one on gravitation that omits Kepler's laws or one on the theory of the complex variable that omits Cauchy's theorem. Duhem actually insists at a much later stage that we must accept testimony; but we could not even arrive at the meanings of words without the process that he has rejected.

H. JEFFREYS.

MAINLY ON WILD GEESE

Through the Air

Adventures with Wild Fowl, and Small-boat Sailing. By Michael Bratby and Peter Scott. Pp. 128+21 plates. (London: *Country Life*, Ltd., 1941.) 10*s.* 6*d.* net.

THIS is a reprinted account of a series of broadcasts which Michael Bratby has made, mainly upon wild geese, and there are a number of black and white illustrations by his friend Peter Scott. There are also two excellent photographs of a pink-footed goose on her nest, evidently in Iceland or Greenland, and a magnificent photograph of an Arctic hare. Unfortunately, we are left in the dark as to who took these outstanding photographs. There are two very good photographs (facing pp. 57 and 60), taken, we are told, in Icelandic waters. Judging from the icebergs the climatic conditions that season in Iceland must have been exceptionally severe, and the conditions recorded resemble, rather, Greenland or Spitsbergen. There is a most interesting account (pp. 29, 30) of a flight of blue snow geese descending on the water on migration in dense mist and being swept over Niagara Falls. Most were killed during that tremendous descent, but a few survived, and were brought to England.

Another interesting record (pp. 66–68) is of a pink-footed goose which had been shot and slightly 'winged'. This bird became very tame, a mate was provided for her, and seven years after she was 'winged' the goose nested in a flower bed in the garden and reared a family. There she lived for twelve years, and then, as circumstances had altered for her human friends, she was given away. She was less happy in her new surroundings, and being fully winged, joined a skein of wild pink-footed geese, and was not seen again.

By the way, the author is wrong when he writes of the wings of the lesser black-backed gull (p. 80) as being "as black as coal". The wings of the British lesser black back are soot-grey, but the wings of the Scandinavian lesser black back are black.

SETON GORDON.

RADIOACTIVITY AND THE COMPLETION OF THE PERIODIC SYSTEM*

By PROF. F. A. PANETH
University of Durham

ONE of the tributes paid by the Government and men of science of the U.S.S.R. to the memory of Mendeléeff on the occasion of the centenary of his birth[1] was the publication of his "Collected Works". It contains all the different tables of the Periodic System designed by Mendeléeff at various times, and so offers an excellent opportunity to study at what pace, and up to what point, the completion of the system proceeded during his life. In the first tables, which appeared around the year 1870, empty spaces were left for the elements eka-boron, eka-aluminium and eka-silicon; for eka-, dwi-, tri-, and chatur-manganese; for the rare earth elements between barium and tantalum (many of which were known but could not be assigned to definite places); for several elements between bismuth and uranium; and, to complete the last horizontal row, for a few trans-uranium elements. The atomic weight of tellurium was assumed to be 125, instead of the experimental value 128, in order to make it smaller than that of the following element iodine, 127. All these statements were equivalent to predictions. Which of them did the author see fulfilled ?

Periodic Classification of the Chemical Elements

Period	Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
I																	1 H 1·0080	2 He 4·003
II	3 Li 6·940	4 Be 9·02											5 B 10·82	6 C 12·010	7 N 14·008	8 O 16·0000	9 F 19·00	10 Ne 20·183
III	11 Na 22·997	12 Mg 24·32											13 Al 26 97	14 Si 28·06	15 P 30·98	16 S 32·06	17 Cl 35·457	18 A 39·944
IV	19 K 39·096	20 Ca 40·08	21 Sc 45·10	22 Ti 47·90	23 V 50·95	24 Cr 52·01	25 Mn 54·93	26 Fe 55·85	27 Co 58·94	28 Ni 58·69	29 Cu 63·57	30 Zn 65 38	31 Ga 69·72	32 Ge 72·60	33 As 74·91	34 Se 78·96	35 Br 79·916	36 Kr 83·7
V	37 Rb 85·48	38 Sr 87·63	39 Y 88·92	40 Zr 91·22	41Nb 92·91	42 Mo 95·95	43 —	44 Ru 101 7	45 Rh 102·91	46 Pd 106·7	47 Ag 107·880	48 Cd 112·41	49 In 114 76	50 Sn 118·70	51 Sb 121·76	52 Te 127·61	53 I 126·92	54 X 131·3
VI	55 Cs 132·91	56 Ba 137·36	57–71 Rare Earths†	72 Hf 178·6	73 Ta 180·88	74 W 183·92	75 Re 186·31	76 Os 190·2	77 Ir 193·1	78 Pt 195·23	79 Au 197·2	80 Hg 200·61	81 Tl 204 39	82 Pb 207·21	83 Bi 209·00	84 Po 210	85 —	86 Rn 222
VII	87AcK 223	88 Ra 226·05	89 Ac 227	90 Th 232·12	91 Pa 231	92 U 238·07	93 —											

† Rare Earths.

VI 57–71	57 La 138·92	58 Ce 140·13	59 Pr 140·92	60 Nd 144·27	61 —	62 Sm 150·43	63 Eu 152·0	64 Gd 156·9	65 Tb 159·2	66 Dy 162·46	67 Ho 164 94	68 Er 167·2	69 Tu 169·4	70 Yb 173·04	71 Lu 174·99

Fig. 1

In 1886 Mendeléeff himself answered this question in a very original way. He had four photographic portraits mounted in a common frame, with the autographs of the persons represented and his own commentary on the back. (The second volume of the "Collected Works" contains a reproduction of this highly interesting historic piece.) The four men and their contributions to the development of the Periodic System, as explained by Mendeléeff, were : Lecoq de Boisbaudran, discoverer in 1875 of gallium (eka-aluminium) ; L. F. Nilson, discoverer in 1879 of scandium (eka-boron); Cl. Winkler, discoverer in 1886 of germanium (eka-silicon); and the Czech chemist B. Brauner, who had greatly pleased Mendeléeff by confirming by a re-determination of the atomic weight of tellurium that it actually was 125, as expected by Mendeléeff.

When in 1905, reviewing the question, Mendeléeff prepared for the last time a table of the Periodic System, scandium, gallium and germanium were filling the lowest three of the formerly empty spaces, but still none of the higher homologues of manganese could be added, and the placing of the rare earths had made but little progress ; there were now indeed twenty instead of nineteen spaces available between barium and tantalum—thanks to the addition of the rare gases as Group 0 of the System, the only really important development between 1886 and Mendeléeff's death in 1907. The atomic weight of tellurium was now assumed to be equal to that of iodine ; Mendeléeff apparently persistently refused to believe that it was even higher (as proved by the best atomic weight determinations), although Brauner himself had admitted that his earlier low value was an experimental error. The last horizontal row shows radium in its proper position and so points to a future development—the placing of the other radioactive elements and hence the conception of isotopy —which Mendeléeff did not live to see.

If to-day we resume the never-ending task of drafting a table of the Periodic System embodying present knowledge, it will take the form of Fig. 1, or some table similar to it. We are now aware that atomic number and not atomic weight defines the position of an element, and that between barium (atomic number 56) and tantalum (atomic number 73) there are only sixteen places. We have given up hope of assigning the fourteen known rare-earth elements to consecutive groups in the System, and therefore prefer to write them outside its framework. The discovery of hafnium (element 72) filled in 1922 the place of eka-zirconium ; that of rhenium (element 75) in 1925 the place of dwi-manganese. Polonium, radon, actinium *K*, actinium, and protactinium have taken their respective places in the last two horizontal rows. Only three positions below uranium are left empty, those corresponding to the atomic numbers 43, 61 and 85, that is, eka-manganese, a rare earth, and eka-iodine. Before saying more about these, it seems necessary to add a word of explanation to the assignment of an element actinium K to place 87 (eka-cæsium).

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* Substance of a lecture delivered before the Institute of Chemistry n London on Feb. 18.

It is well known that most of the elements from thallium (81) to uranium (92) are represented by more than one atomic species, thanks to the three radioactive disintegration series which start from uranium, actino-uranium, and thorium and emit α- as well as β-particles, thus covering some parts of the Periodic System repeatedly ("Radioactive Displacement Laws"). All three series have, however, one peculiar feature in common, namely, the successive emission of four α-particles, starting from the thorium isotopes ionium, radio-actinium, and radio-thorium, respectively. As a consequence, immediately after element 90 the elements 88, 86, 84, and 82 are formed. The elements 89 and 83 are nevertheless represented in the Periodic System, because the former is produced in the actinium and thorium series before, and the latter in all three series after, the 'four α-particle run'. Elements 87 and 85, however, are missing in the three disintegration series; compare Fig. 2, in which the full line represents the actinium series in the generally accepted form.

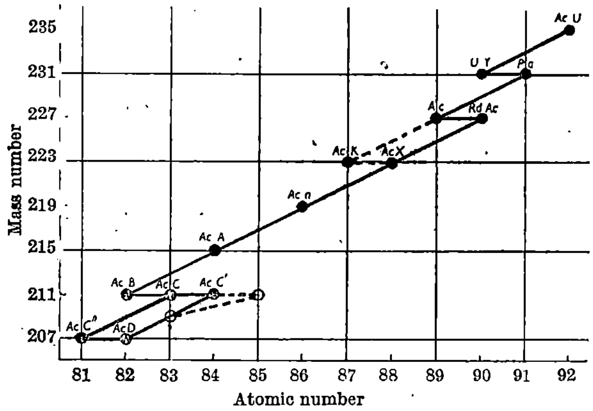

Fig. 2
RELATION OF ELEMENTS 87 AND 85 TO THE ACTINIUM SERIES.

There was always hope of finding the missing elements outside the main series as so-called 'branch products', and it was easy to predict theoretically, on the basis of the displacement laws, which atoms would have to undergo a 'dual disintegration' in order to produce the looked-for effect. If any one of the emanations emitted β-particles (in addition to their well-known α-radiation), or if either actinium or its isotope mesothorium 2 emitted α-particles (in addition to their β-radiation), the result would necessarily be an isotope of element 87. Experiments proved that neither in the uranium nor the thorium series does such a branching occur[2]. On the other hand, it was found in Vienna[3] so early as 1914 that carefully purified actinium emitted, in very small intensity compared with the activity of the main series, α-rays of the range (in air at N.T.P.) of 3·4 cm. The possibility was considered that this indicated a "dual disintegration of actinium, a small percentage of the atoms emitting α-particles, the great majority β-particles". The result of the α-radiation would, of course, be the element 87. The continuation of these researches was prevented by the outbreak of war, but three years ago Mlle Marguerite Perey[4] in Paris not only confirmed the existence of α-rays from actinium of the range observed in Vienna, but also was able to show that in purified actinium solutions to a small extent a β-radiating substance of a half-value period of 21 minutes is constantly formed; that this substance cannot be removed by the precipitation of sulphides or carbonates, but that it can be crystallized together with cæsium perchlorate or chloroplatinate. It seems most likely that this β-radiating substance with the properties of an alkali metal is the product of those comparatively few actinium atoms which emit α- instead of β-particles, and possesses therefore the atomic number 87. Of 1000 atoms, less than 10 seem to follow this path. (In the disintegration of actinium C the proportion is reversed; about 2 in 1000 emit β-particles while the rest decay with α-emission to actinium C″.) The β-radiation displayed by this element 87 would necessarily lead back to an element 88, probably identical with actinium X, in the same way as both routes starting from actinium C unite in actinium D. See Fig. 2; the abscissa shows the atomic number (that is, number of protons) of each atom, the ordinate its mass number (that is, nearest integer to the atomic weight, or number of protons plus neutrons).

Further confirmation of Mlle Perey's experiments is certainly desirable. The fact, however, that she was able to follow the decay as well as the growth of the 21-minutes substance, and the agreement of the chemical evidence with the observed α-radiation of actinium, is very assuring. As the name "actinium K" has been suggested for this new element we have inserted its symbol AcK in place 87 of our Periodic Table (Fig. 1).

There is so far no trustworthy indication of a branching of any of the main radioactive series leading to an element 85, nor has a stable form of this element been found. We must assume at present that the elements 43, 61 and 85 are missing on our earth. The regularities of the Periodic System enable us to describe approximately the properties to be expected from these elements; but especially for 85, since it is on the border line between metals and non-metals, and without a higher homologue, such predictions are necessarily vague. Fortunately for the interests of chemists who are systematically minded, there is a possibility of studying experimentally the properties even of elements which are not represented in Nature: we can try to make them, and if we are lucky enough to obtain them in a (not too short-living) radioactive form, the well-known methods of radio-chemical investigation, that is, a combination of electrometrical measurements with analytical-chemical operations, will enable us to explore their chemical behaviour even if quantities of only 10^{-10} gm. or less have been produced.

The most efficient instrument for atomic transmutation is E. O. Lawrence's cyclotron. Of the overwhelming number of nuclear reactions carried out with its help, for the purpose of our present survey, in which we intend to omit all details of no immediate interest to the chemist, we need remember only two. In many cases when an atom of atomic number Z and mass number M is bombarded with deuterons (${}^{2}_{1}D$), an atom of atomic number $Z+1$ and mass number $M+1$ makes its appearance while one neutron per atom is liberated. If the bombardment is carried out with helium nuclei (${}^{4}_{2}He$), an element $Z+2$ of mass $M+2$ may be formed, this time with emission of two neutrons per atom. The newly created atoms are mostly unstable; thus these two reactions give us the possibility of producing radioactive elements one and two places higher in the Periodic System than the bombarded elements. Their application has provided active forms of all three missing elements for chemical investigation. Here are the main results.

Element 43, Mendeléeff's eka-manganese, was obtained by bombarding element 42, molybdenum, with deuterons[5]. At least five radioactive isotopes of atomic number 43 were recognized; as their half-value periods were of the order of hours and days, a study of their chemical behaviour was possible. It was found that element 43 can be precipitated with hydrogen sulphide from alkaline and (not too) acid solutions; that it can easily be deposited electrolytically; and that its oxide is volatile. All this shows that it resembles more its higher homologue, rhenium, than its lower, manganese. It may be mentioned that the identity of one of the isotopes with element 43 could be verified even by the measurement of the K_a line of its X-ray spectrum; not in the usual way, of course, by exciting it on the anticathode of an X-ray tube, but through the spontaneous emission of this line as a consequence of the transition from a higher to a lower isomeric state of the nucleus.

For the production of element 61 both the atomic reactions mentioned above have been successfully tried. When element 60 (neodymium) was bombarded with deuterons[6], a radioactive isotope of element 61 with a half-value period of a few hours was obtained; bombardment of element 59 (praseodymium) with α-particles[7] resulted in a radio-element 61 of a half-value period of about 200 days. In this case the chemical character can be deduced with great certainty from the position in the Periodic System; element 61 must be a rare earth, of a basicity higher than samarium and lower than neodymium. It is a task for the chemist now to test this prediction with the help of one of the radioactive isotopes of 61, but scarcely anything else of interest can be expected from an investigation of invisible quantities of this new member of the rare earth group.

Far more important, for the reasons given above, is the chemical study of element 85, and it deserves special consideration also on account of its radioactive behaviour. Since the element one place lower down, polonium, is not available in sufficient quantities for a bombardment, the most promising reaction was the treatment of the element two places below, bismuth, with helium nuclei accelerated in the cyclotron. It was found that, besides others, the following sequence of reactions took place[8]:

$$^{209}_{83}\mathrm{Bi} + {}^{4}_{2}\mathrm{He} \longrightarrow {}^{211}_{85} + 2\,{}^{1}_{0}n$$
$$^{211}_{85} + {}^{0}_{-1}e \longrightarrow {}^{211}_{84}\mathrm{AcC}'$$
$$^{211}_{84}\mathrm{AcC}' \longrightarrow {}^{207}_{82}\mathrm{AcD} + {}^{4}_{2}\mathrm{He}$$

The first line shows that element 85 is formed accordng to expectations; its instability is, however, of a peculiar type, as indicated by the second line: nstead of emitting positrons its nuclei capture electrons (out of the K-shell) and are thereby transformed in atoms of a well-known natural radio-element actinium C′, an isotope of polonium. This process goes on with a half-value period of 7·5 hours. Actinium C has a much shorter period, only 5×10^{-3} ec.; it is, therefore, always present in element 85 in equilibrium quantity, and its α-radiation (range 6·5 cm.) decays with the half-value period of its parent, namely, 7·5 hours. That makes it possible to investigate the chemical properties of element 85 as though it were itself emitting the α-rays. The final product must be the same as that of the ordinary AcC′, namely actinium D, or 'actinium lead', of atomic weight 207. (It seems likely that the same final product is also reached by another way, as element 85 actually undergoes a dual disintegration, about half its atoms emitting α-particles.) In Fig. 2 we have indicated by dotted lines the way in which element 85, artificially produced from $^{209}_{83}$Bi, is changing into the natural radio-element AcC′. This example, which is not the first of its kind, illustrates well that there is no fundamental difference between 'artificial' and 'natural' radioactivity; it is therefore better to speak of 'artificially produced', and not of 'artificial', radio-elements.

Thanks to the favourable decay period of more than seven hours, the chemistry of element 85 can be thoroughly studied. The following reactions are of special interest. Mixed with bismuth it is quantitatively precipitated by hydrogen sulphide in acid solutions. Fractional hydrolysis of bismuth nitrate enriches element 85 in the first fractions; since it is known that the tendency of polonium to hydrolyse is already greater than that of bismuth, it would be interesting to compare in this respect element 85 with polonium. Closely connected with hydrolysis is the very characteristic feature of polonium of behaving like a colloid in all but strongly acid solutions; the same pecularity should be easily detectable in solutions of element 85. If this 'eka-iodine' is mixed with iodine, it cannot be precipitated, together with the latter, by silver nitrate, and it is only partly extracted by carbon tetrachloride. It can be deposited electrolytically. It is not precipitated by hydrochloric acid, in presence of lead. Its faculty of forming a volatile hydride has not yet been demonstrated conclusively; this one chemical property, however, can be predicted with complete confidence, since it depends directly on the position of an element in the Periodic Table—which must precede a rare gas by not more than four places—and is shown even by the still more metallic elements polonium and bismuth. It should be not too difficult an experiment to compare the stability of the gaseous hydride of 85 with that of HJ and H_2Po.

It is clear from the above that element 85 differs in important reactions from its lower homologue iodine and resembles more its left-hand neighbours in the VIth period. It is all the more interesting that some similarity to iodine is reported in its physiological behaviour; it is concentrated in the thyroids of guinea pigs.

It has been mentioned before that Mendeléeff, in some of his tables, reserved room for trans-uranium elements. The ease with which in many cases artificial transmutation generated elements higher in the Periodic System than the bombarded ones naturally led to experiments to create these trans-uranides. For a while it was believed that, by a neutron bombardment of uranium, radioactive elements up to atomic number 96 could be obtained. Careful chemical investigation proved, however, that most of the elements thus produced were fission products of uranium, radioactive isotopes of elements placed much lower in the Periodic Table; for example, bromine, strontium, antimony, tellurium, xenon and barium. However, element 93, that is, the one immediately following uranium, was synthesized in an active form and its chemical character studied[9]. It seems that here, too, the similarity with the preceding element, uranium, is greater than with its lower homologue, rhenium. Element 93 is, for example, not precipitated by hydrogen sulphide in acid solution, and does not possess an oxide volatile at red heat.

Finally, the question may be considered how great is the chance that the elements which so far have only been produced artificially occur in Nature. For the elements 43 and 61 it is certainly very small, for experimental as well as theoretical reasons. We have seen that the analytical-chemical properties of element 43 are very much like those of rhenium, and that there is no reason to doubt that element 61 follows the other rare earths. Now rhenium has been prepared in hundreds of kilograms, but not the slightest trace of element 43 was ever found associated with it. For element 61 a special search has been made, among others, by Auer von Welsbach, who not only had unusually large quantities of rare-earth material at his disposal but possessed also an unrivalled experience in their fractional separation; he came to the conclusion that no rare earth existed between neodymium and samarium.

To this we may add that, quite independently of these experimental facts, a general rule seems to exclude the possibility of a stable element 43 or 61. J. Mattauch[10] has directed attention to the absence, or, at least, extreme rarity, of stable isobars (that is, atoms of equal atomic weight) belonging to neighbouring elements. If two neighbours in the Periodic Table have isobars, one of the atomic species is almost invariably unstable, changing into its isobar by emission of an electron or a positron (or both). For example, ${}^{40}_{19}\mathrm{K}$ is isobaric with ${}^{40}_{18}\mathrm{A}$ and with ${}^{40}_{20}\mathrm{Ca}$; in accordance with Mattauch's Rule, ${}^{40}_{19}\mathrm{K}$ emits β-particles, thus changing into ${}^{40}_{20}\mathrm{Ca}$ (and perhaps also positrons, thereby producing ${}^{40}_{18}\mathrm{A}$, the astonishing terrestrial abundance of which has been tentatively explained by this assumption). If Mattauch's Rule is valid in the region of the elements 43 and 61, there are no stable isotopes of these two elements possible, as all mass numbers are occupied by stable isotopes of their neighbours. Element 42, molybdenum, possesses the stable isotopes 92, 94, 95, 96, 97, 98 and 100; element 44, ruthenium, 96, 98, 99, 100, 101, 102 and 104; so for element 43, the combining weight of which ought to be between molybdenum and ruthenium, no atoms with masses between 94 and 102 are available. The case of element 61 is similar.

For element 85 Mattauch's Rule makes no prediction, since from element 84 onwards no stable atoms are known. Nor are the negative results of the experiments carried out so far in search of this element conclusive; for it was generally supposed that in the course of analytical separations it would follow iodine, while we know now that it is much more like polonium and bismuth. The task of a chemist embarking to-day on a new attempt at its discovery would be facilitated not only by this knowledge but also by the opportunity of adding the artificially produced radioactive form of element 85 as an 'indicator' to his material; the α-rays, decaying with the characteristic period of 7·5 hours, would show him at once in which fraction the looked-for natural element, if present at all, is concentrated.

Even if it should be impossible to detect any of the three missing elements on the earth, it is not unlikely that they possess a transitory existence in the course of the innumerable thermo-nuclear reactions occurring in the interior of the sun and the other stars.

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[1] See NATURE, **134**, 799 (1934).

[2] Hahn, O., *Naturwissen.*, **14**, 159 (1926).

[3] Meyer, St., Hess, V. F., and Paneth, F. A., *Sitzber. Wien. Akad. Wiss.*, **123**, 1459 (1914).

[4] Perey, M., *C.R.*, **208**, 97 (1939); *J. Phys. et le Radium*, **10**, 435 (1939).

[5] Seaborg, G. T., and Segrè, E., *Phys. Rev.*, **55**, 808 (1939); Segrè, E., NATURE, **143**, 460 (1939).

[6] Pool, M. L., and Quill, L. L., *Phys. Rev.*, **53**, 437 (1938); Law, H. B., Pool, M. L., Kurbatov, J. D., and Quill, L. L., *Phys. Rev.*, **59**, 936 (1941).

[7] Kurbatov, J. D., MacDonald, D. C., Pool, M. L., and Quill, L. L., *Phys. Rev.*, **61**, 106 (1942); Wu, C. S., and Segrè, E., *Phys. Rev.*, **61**, 203 (1942).

[8] Corson, D. R., MacKenzie, K. R., and Segrè, E., *Phys. Rev.*, **58**, 672 (1940).

[9] McMillan, E., and Abelson, P. H., *Phys. Rev.*, **57**, 1185 (1940).

[10] Mattauch, J., *Phys. Z.*, **35**, 617 (1934); *Naturwiss.*, **25**, 738 (1937).

MOSQUITO-BREEDING IN STATIC WATER SUPPLIES

By J. F. MARSHALL, C.B.E.
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IN countries such as Great Britain, where neither malaria, yellow fever nor other mosquito-borne diseases are endemic, consideration of the habits of these insects in connexion with war has scarcely ever been necessary. During the War of 1914–18, it is true, quite extensive outbreaks of malaria occurred in England owing to the fact that soldiers who had contracted the disease abroad were sent to convalesce in districts where *Anopheles maculipennis*, the chief malaria-carrier of Europe, was then (as now) particularly prevalent[1]. It may perhaps also be noted that neglect of agricultural drainage during that war led to a marked (and in some cases serious) increase in the mosquito infestation of many low-lying areas of Great Britain.

Neither of the above-mentioned contacts between British mosquitoes and war, however, attracted more than local interest; and it was only in the early part of last year, when fire-fighting authorities commenced to instal very large, open-air tanks all over the country, that any such association can be said to have become a matter of general concern. Although public knowledge regarding mosquitoes is extremely limited, most people are aware of the fact that static water is liable to encourage them: hence the appearance of these conspicuous receptacles throughout our urban areas has unavoidably given rise to considerable apprehension. It seems therefore advisable to consider, first, how far these misgivings are justifiable; and, secondly, to what extent precautionary measures can and should be adopted.

In theory, the 'control' of mosquitoes is a comparatively simple matter, owing to the fact that both their larval and pupal stages of development are passed entirely in water. Mosquitoes of the Culicine tribe (to which all but four of the British species belong) breed exclusively in static water; but those of the Anopheline tribe breed also (and in the case of many species chiefly) in running water—their larva being able to anchor themselves to surface weeds by means of certain hook-ended hairs. It thus follows that mosquito-control operations include (in addition to the obvious procedure of abolishing potential breeding-places by drainage, filling-in, etc.) the clearing and re-grading of ditches and the removal of aquatic vegetation. It frequently happens, however, that lack of time (or of funds) renders such measures impracticable, in which case an alternative method is to kill the larvæ, either by spraying oil upon, or mixing 'larvicidal' chemicals with, the infested water. In the former case the oil dissolves away a hydrofuge secretion from within the breathing orifices of the larva and then enters the tracheal system with fatal results[2]; in the latter case the larva is poisoned when it feeds. For larvicidal purposes preparations based on coal tar derivatives and introduced into 30,000–50,000 times their own volume of the infested water are most commonly employed. It is important to note, however, that water should on no account be treated with either oil or larvicide if the presence of mosquito larvæ has not been actually observed: treating uninfested water being not only a sheer waste of both time and money but also liable to destroy fish, water bugs and various other 'mosquito enemies' that natural collections of water so frequently contain.

Although all the above-mentioned operations are simple in themselves, the practical application of them is a much more complicated matter than it sounds. This is chiefly due to the numerous idiosyncracies that characterize different species of mosquitoes, notably in regard to the quality and environment of the water that they instinctively select for oviposition. (Some British species lay their eggs separately on water; others lay them separately on land liable to flooding; others stick them together during laying, so as to form 'egg-rafts'. The species *Culex pipiens*, *C. molestus* and *Theobaldia annulata* belong to the last-mentioned group.) Of the thirty species at present known in Great Britain, seven have been but rarely recorded, but the habits of the remaining twenty-three have been more or less thoroughly studied. Of the species included in the latter group, eight are known to breed chiefly in woodland pools; three, exclusively in rain-filled cavities in trees; two, almost exclusively in slow-running, weedy water; two, chiefly, and one, exclusively, in the salt or brackish water of coastal marshes—and so on. The coastal species have an exceptionally long flight-range and are consequently able to cause annoyance in localities several miles distant from their breeding-grounds.

In regard to the breeding of mosquitoes in tanks, reservoirs and other containers, it has until recently been believed that only two British species—namely *Culex pipiens* Linnæus and *Theobaldia annulata* Schrank—are at all likely to do so. Of these two mosquitoes, the former breeds impartially in either clean or foul water; the latter chiefly in water contaminated by sewage or other nitrogenous matter. Under natural conditions, *C. pipiens* rarely, if ever, bites human beings (its customary victims being birds), but *T. annulata* avidly does so. These facts indicate that tank-stored water, unless allowed to become contaminated in the manner above mentioned, is unlikely to give rise to any 'mosquito annoyance' other than the possible public apprehension that the sight (or sound) of any species of mosquito is liable to arouse.

Although, however, this assumption may still hold true where tanks in open-air situations are concerned, it would be unsafe to consider it generally applicable until the breeding habits of another British mosquito, namely, *Culex molestus* Forskal, have been more fully investigated. Both in the larval and adult forms this species resembles *C. pipiens* so closely that its presence in Great Britain remained unnoticed until 1934, when it was accidentally discovered at Hayling Island (Hants)[3]. Previous to its being found in Great Britain, the presence of *C. molestus* in other parts of Europe (for example, in France[4], Germany[5], Greece[6], Hungary[6] and Malta[6]) had already been detected, and its biology studied, by Continental and other entomologists, who considered it to be an abnormal 'variety' of *C. pipiens* rather than a separate species. The author's reasons for preferring the latter classification have been fully expounded elsewhere[7].

To say the least, the biological peculiarites of *C. molestus* are extremely striking. Of the two thousand odd species of mosquitoes at present described, less than a dozen are known to be stenogamous (that is, able to mate in a very small space) and only three to be autogenous (that is, able to lay fertile eggs without having had a blood meal before or after mating). Not only does *C. molestus* differ from both *C. pipiens* and *T. annulata* in being both stenogamous and autogenous, but it also differs from the former species in being an extremely fierce 'man-biter' whenever opportunities occur.

It was suggested that the detection of *C. molestus* in Great Britain might supply the long-awaited explanation of mysterious cases, reported from time to time, in which human beings had been fiercely bitten (notably in houses and tube railways in London) by mosquitoes diagnosed as *C. pipiens*. The accuracy of this suggestion was afterwards established by the investigation of '*molestus* plagues' occurring in houses in Hull[9]; in houses in Westminster and other Thames-side districts of London (for example, Battersea, Bermondsey, Chelsea, Deptford, Fulham and Greenwich); and in various stations of the already mentioned tube railways.

In addition to being both stenogamous and autogenous, *C. molestus* is also homodynamic (that is, able to breed at any time of the year provided that external conditions remain favourable). Possessing these three unusual characteristics, it is very easily bred in the laboratory all the year round; but, in spite of this fact, our knowledge regarding its natural breeding habits is unfortunately far from complete.

In the case of the tube railways, however, larvæ of this species were found to be heavily infesting collections of water stagnating under station platforms and between the lines. They have also been found in flooded cellars and cesspools, in underground systems of household waste disposal, in septic tanks, in cavities within a water-logged rubbish dump and in the underground tanks of a Thames-side laundry. Consideration of the above and certain other facts have led some entomologists to suggest that *C. molestus* may breed chiefly in water which, in urban and other built-up localities, is allowed to stagnate in dark, underground situations; and since, both in London and elsewhere, static water is now being stored in the basements of many houses, the possibility of *C. molestus* being thus provided with facilities for extending the range of its undesirable activities appears to be far from remote. (Should any such developments occur, the covering of ventilators, window openings, etc., to prevent gravid females of this species from reaching the water, might perhaps be deemed advisable.) It is obviously important that tanks of this kind should be kept under observation, and specimens of any mosquito larvæ seen collected for identification.

Whether even the 'man-ignoring' *C. pipiens* is likely to breed in the very large outdoor tanks that are now in use is still a matter for speculation. Should such cases occur, the question of applying oil or larvicide merely to allay public apprehension must presumably receive consideration. It has to be noted, however, that oil is extremely injurious to tanks with bituminous linings.

As already mentioned, tank-stored water that is allowed to become contaminated by sewage or other nitrogenous matter will very probably become infested with larvæ of the man-biting species *T. annulata*. Attention has, moreover, been directed to the possibility of tank-stored water becoming a suitable breeding medium for certain of our more 'countrified' species, owing, for example, to algal development or to the accidental or mischievous introduction of vegetable or other organic matter. It is, however, obviously preferable to deal with such contingencies if and when they arise rather than to adopt the spendthrift policy—advocated in some quarters—of indiscriminately treating enormous numbers of tanks on the off-chance of a few of them containing mosquito larvæ. These creatures are so easy to recognize that anyone who has ever seen one—whether in a specimen tube or a tank—can have no difficulty whatever in deciding when anti-larval measures are necessary.

[1] Marshall, J. F., "The British Mosquitoes", p. 319 (British Museum 1938).
[2] Keilin, D., Tate, P., and Vincent, M., *Parasitology*, 27, 257 (1935).
[3] Marshall, J. F., and Staley, J., NATURE, 135, 34 (1935).
[4] Roubaud, F., *C.R. Acad. Sci.*, 188, 735 (1929).
[5] MacGregor, M. E., *Trans. Roy. Soc. Trop. Med. and Hyg.*, 26, 307 (1932).
[6] Tate, P., and Vincent, M., *Parasitology*, 28, 512 (1934).
[7] Marshall, J. F., and Staley, J., *Proc. Roy. Ent. Soc.*, A, 12, 17 (1937).
[8] Marshall, J. F., and Staley, J., *Parasitology*, 27, 4 (1935).
[9] Marshall, J. F., and Staley, J., NATURE, 136, 641 (1935).
[10] Shute, P. G., *Lancet*, 1, 6 (1941).

SCIENCE AND WAR*

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FROM the earliest times of which we have a record to the present day, the history of man has been marked by constant changes in the social systems, changes that often were abrupt and violent. One form of social structure or of government has succeeded another. Small but powerful social or political units have grown by accretion or by conquest into great kingdoms or empires. These kingdoms or empires eventually have decayed or fallen apart.

Together with these frequent social, political, or economic readjustments of the past we see a constant and fairly continuous development of other forces which to a large extent are independent of transient political conditions. We note a growing interest in and understanding of the products of the earth and their uses. We also are able to trace the ever-increasing subjugation of the forces of Nature, which more and more come to be the servants instead of the enemies of man.

The greatest of all human achievements was the control and use of fire. We have no knowledge of when or how fire was first transformed from a terrifying natural phenomenon into man's most usefu servant. Second among human achievements wa the fashioning and use of tools and weapons. Th origin of the use of tools is lost in the far distan past. Then came the weaving of textiles from plan or animal fibres and the moulding of pottery vessels followed by the appearance of bronze. Not long afte the appearance of bronze utensils of various sorts the wheel and axle appeared in Asia, soon spreading to Europe.

From the Bronze Age onward the knowledge o the use of natural products and the control of natura forces have shown a fairly continuous development

Since the beginning of the present century th advance in the knowledge and understanding of th products and forces of Nature has been greater than in all the thousands of years preceding—or at leas since the subjugation of fire, the first fashioning o tools, and the domestication of animals and plants

Whether we like the idea or not, we are now living in an age, and under conditions, in which scienc plays a dominant part, and the established scientifi principles that underlie many of the most familia of our present-day improvements were unheard of or considered fallacious, no longer than a generation ago. This is self-evident to all; but the implication inseparable from a culture based ever more intensely and extensively on increasingly abstruse science are not as yet fully appreciated.

The progress that through the ages has been made in the understanding of natural phenomena and in the utilization of natural products is continuing a an accelerated pace, and will continue in the future in spite of what may happen in the next few years It may be locally obstructed, or even brought to an end, but somehow, somewhere, it will carry on.

The present struggle is no more a contest in the military field than it is in the field of science. It is quite possible to win the War on the battle front, but lose it in the laboratory. We must see to it that, so far as possible, the steady advance of science is maintained. At the present time we are utilizing to the maximum extent our scientific resources and our scientific personnel to aid in our war effort. But this is not enough. Various branches of science not of immediate military application are in the long run quite as essential for our progress and our welfare as are those forms of engineering, of physics, and o chemistry that underlie the construction and the use of modern implements of warfare. These are the many and varied types of pure science, lines of work leading to results seemingly of no importance that all too often are regarded merely as a form of mental exercise undertaken solely for the persona satisfaction and gratification of the person concerned. What we call pure science is simply a branch of science for which no economic application has as yet been found. But at any time a body of unco-ordinated facts may suddenly and unexpectedly fit into an integrated whole, to our advantage Without its advance fringe of competent workers in pure science constantly probing the great unknown and accumulating masses of data with no apparent immediate application, the broader aspects of scientific progress soon would languish. Pure science is likely to suffer severely in times like the present—in times when it would seem to be the wisest course to give it the maximum encouragement.

In the democracies, progress in any line of science is mainly dependent upon the willingness of the people to support work in that particular line which, in turn, is dependent upon popular interest and appreciation.

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* Substance of the address of the retiring president of the Washington Academy of Sciences delivered at the 309th meeting of the Academy on January 15.

There are people who are by no means science-minded. Their attitude varies all the way from passive superciliousness to outspoken hostility. We who are engaged in scientific work, and who understand its importance in the general complex of present-day human affairs, often fail to realize how recently science has been able more or less successfully to overcome various forms of popular prejudice and to secure the favour of a very large section of the general public.

The present popular attitude towards science cannot properly be understood without some knowledge of the public attitude in the more or less recent past. I propose, therefore, to digress here in order to indicate briefly the changes that have taken place here and in England since the early days of the settlement of the United States. At that time, in the reign of Queen Elizabeth, Galileo was still a student at the University of Pisa, Tycho Brahe had just completed his observatory, and Paracelsus and Agricola only recently had died. In those days science was almost wholly included in the subject of theology, and scientific work was restricted within narrow bounds by the dogmas of the theologians.

For some time there had been a growing restiveness against the restrictions placed on scientific investigations by the theologians. This restiveness began to take the form of concerted action in the first half of the seventeenth century. As early as the reign of Charles I, about 1645, there existed in England an organization referred to by the Hon. Robert Boyle, seventh son of the first Earl of Cork, as the "Invisible College". This "Invisible College" was first suggested by Theodor Haak (or Hank), a German from the Palatinate, then resident in London. It consisted of weekly meetings at which the results of experimental work in philosophy, in its broad sense, were discussed. This was rather an unorthodox procedure for the time, but those who attended the meetings were among the ablest men of England, and included theologians as well as others. One of the theologians was Dr. John Wilkins, afterwards Bishop of Chester, who had married Robena, sister of Oliver Cromwell. Another participant was Sir Christopher Wren, who later laid down the plan for the College of William and Mary.

According to Dr. Cromwell Mortimer, "had not the Civil Wars happily ended as they did, Mr. *Boyle* and Dr. *Wilkins*, with several other learned men, would have left *England*, and, out of esteem for the most excellent and valuable Governor, *John Winthrop* the younger, would have retir'd to his new-born Colony [Connecticut] and there have established that *Society for promoting Natural Knowledge*, which those Gentlemen had formed, as it were, in *Embryo* among themselves".

Emigration to America was, however, forestalled. On November 28, 1660, the "Invisible College" became visible as "The Royal Society of London for Improving Natural Knowledge". On the Wednesday following, word was brought that King Charles II approved the design of the meetings; in October 1661, the King offered to be entered as one of the Society; and in the next year the Society was incorporated under the name of the Royal Society, the first charter of incorporation passing the Great Seal on July 15, 1661.

Although the Royal Society remained in England, both the College of William and Mary and Harvard College received considerable amounts of money from the estate of Boyle after his death in January 1691–92.

Science now began to assume a new aspect. Charles II had in effect declared that there is nothing irreligious in reporting facts. So records of observed facts and their interpretation in the light of other facts began to supersede introspection in which the aid of facts was regarded as superfluous, combined with interminable commentaries on the works of Aristotle.

Following the Restoration, science in Britain became largely an occupation of the aristocratic and the wealthy, and for the most part was followed along lines that had little or no economic application. In the public mind it came to be identified more or less completely with the aristocracy and to be regarded as partaking of the same aloofness from the general run of human affairs that characterized the social life of the upper classes. The natural result of this was that when, in the Victorian era, the champions of the lower classes began to gain a considerable following, they, or at least many of them, attacked science as one of the perquisites of the aristocracy. This attitude is well illustrated by Charles Dickens's "Mudfog Papers" published on the occasion of the first meeting of the British Association for the Advancement of Science.

Since that time science in England gradually has come more and more into popular favour. Applied science has made rapid strides and is now quite as fully developed and as highly regarded as it is in any other land. The rise in the prestige of applied science, however, has not been accompanied by any noticeable decline in the popularity of pure science, so that here we find the two types advancing side by side in more or less ideal balance. But, unfortunately, science in Britain still does not have the complete confidence of the public, and is not by any means free from neglect, disparagement, or even attack in the popular Press.

In the United States the history of science has been somewhat different. In early Colonial times scientific effort was devoted mainly to making known the natural resources of the new land, particularly the plant and animal life. But applied science early attracted the attention of the colonists. In later Colonial times applied science, especially in certain engineering branches, was systematically discouraged in the fear that the Colonies might become competitors of the mother country in the production of manufactured goods. It was possibly partly as a reaction from this suppression that after the Revolution science stood high in the favour of the representatives of the American people, its most insistent and powerful advocates being Thomas Jefferson of Virginia, Benjamin Franklin of Pennsylvania, and John Adams of Massachusetts. But it was some time before the new country was sufficiently well organized to enable the people to devote much thought to science. When they did, a spontaneous interest, taking various strange and crude forms, appeared, particularly in the agricultural areas. This crude popular science—and pseudo-science—gradually became amalgamated with the more orthodox science of the schools and colleges, and we note, especially after the middle of the last century, an enormous expansion of applied science in all forms, later very largely supported by Federal and State appropriations made possible by active and widespread interest among all the different groups in our population.

In the United States popular interest in science is twofold, arising both from the vista of economic betterment resulting from applied science, and from its appeal to the imagination. We all like to look forward to the day when we shall be even more comfortable than we are now. But we all have a non-material side. We like to get away from the hard realities of everyday life and to contemplate the unknown, and beyond that the unknowable. We all would like to know more about the world we live in. What would we find a few hundred miles down in the earth, or 20,000 feet below the surface of the sea ? We would like to know more about the stars : Are there any other worlds like ours ? And what is it like in interstellar space ? We would like to know more about ultimate human origins—indeed, about very many things concerning which our present information is vague and fragmentary. Now although popular interest in science is more general and more widespread in the United States than it is in most other countries, it tends to gravitate in these two directions, towards the directly economic and towards the mysterious. Between these two extremes lies a broad, intermediate field in which the American people as a whole takes little interest, but which is intensively cultivated elsewhere. This is the descriptive branch of pure science, the results of which are of no immediate economic import and are not mysterious.

Popular interest in science must not only be maintained, it must also be increased if we are to hold our own in the years to come, for whether carried on under Government support or in endowed institutions of learning, the full development of our scientific potentialities is dependent upon a sympathetic public attitude. In order to secure, to maintain and to increase public interest in and sympathy towards scientific work, and to convert the still disconcertingly numerous unbelievers, it is essential that we continually provide the public with news regarding scientific progress in all lines of interest to them, from both the material and non-material or philosophical points of view. Such impersonal news is especially desirable in times of national emergency.

Fortunately, in this respect the United States is in an excellent position. More and better science appears in its daily Press and other journals than in those of most other countries, and science is less frequently disparaged and denounced there than elsewhere. For this we have chiefly to thank the National Association of Science Writers, the members of which, in addition to knowing science, know the public mind and are able to present the advances in science in terms everyone can understand.

Progress in science is possible only with the support of an interested and appreciative public. It is also possible only through the efforts of a carefully selected and adequately trained personnel. This is a matter that heretofore has scarcely received the attention it deserves.

At the present time a very serious danger to our continued progress in science has arisen. This is the introduction into the Army of many young men who would be of vastly greater value to the country if they were permitted to continue their studies, or to remain in research positions. The matter is further complicated by the fact that as a rule the most valuable of these young men are those most likely to enlist on their own initiative.

After the War of 1914–18 there was a marked scarcity of able young scientific men. This was most noticeable, perhaps, in the biological sciences, thoug it was more or less noticeable in other branches a well. Many promising young men were killed. Other as a result of several years spent in the variou armies, found themselves unable to make the nece sary readjustment to scientific work. Still othe tried to readjust themselves but were only partiall successful. Breaking the thread of continuity effort between the impressionable boy in the forma tive period and the mature man cannot but resul in a certain amount of dislocation. We are reminde of the old Berber proverb :

> "Teaching boys is like ploughing earth,
> Teaching men is like ploughing rock,
> Teaching old men is like ploughing water."

There are two ways out of this dilemma. Eithe the student may be placed on a deferred list so tha he may be enabled to continue his studies uninte ruptedly, or he may be assisted in carrying on hi work, to whatever degree may be found practicabl while in the Services.

Many young botanists and zoologists would wel come an opportunity for collecting specimens an continuing their studies in regions new and strang to them. Such material as they collected could b sent home to be identified, or to be stored until thei arrival. Activities of this nature carried on in thei spare hours would go far towards overcoming tha feeling of boredom that afflicts almost everyon stationed at an isolated army post or naval base, an there is no reason for believing that these activitie would in any way detract from their military effi ciency. Not only would this work benefit the me engaged in it; it would also go far towards filling man gaps in our knowledge of the distribution of animal and plants, and of other features connected with them

In army posts and naval bases a young zoologis or botanist who spends his spare time catchin insects or pressing plants will at first be an objec of ridicule to his associates, both officers and men His situation, however, is by no means withou precedent—and most honourable precedent. It ma comfort him to realize that the world's leadin authority on the Hesperiidæ, a peculiarly difficul group of butterflies especially characteristic o America, is Brigadier General William H. Evans o the Royal Engineers, while in the Royal Navy Rea Admiral Hubert Lynes is the leading authority on a very puzzling group of small African birds. Som time ago the collections of the British Museum wer enriched by a fine collection of butterflies presente by Captain Lord Byron. Looking at the matter in a more frivolous light, is a young man using his spar time to continue his studies, and at the same tim to advance our knowledge of animals and plants, an more ridiculous than an ancient tough old sea-dog i the forecastle engaged in fine embroidery work wit delicately coloured silks, to the accompaniment o blood-curdling oaths ?

A vast amount of such work has been done by th personnel of foreign armies and navies in the past particularly by officers in the British services. I fact, at one time the United States Navy assigne interested young officers to the Smithsonian Insti tution for instruction in the collection and preserva tion of material.

Whether in its material or in its non-material aspects, progress in science is dependent upon the fostering of the scientific spirit. The scientific spirit is more than mere curiosity. It is an insatiable curiosity that impels one to learn everything that is known about a given subject, and then to go further and broaden and extend that knowledge by personal investigation and research, in spite of all difficulties and discouragements—and these are always many.

The spirit of science is inborn, though it may appear in anybody, anywhere, in any class, or group, or race. In order to develop the scientific spirit to the maximum, as it must be developed if we are to hold our place in the world of the future, we must watch for it at its inception, and whenever and wherever it is found encourage it.

STATISTICAL CONTROL OF PRODUCTION*

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FOR a number of years I had been interested in the general question of tolerances, first from the point of view of pure science and later in its more practical aspects. My interest in this subject was very much focused when I came to the National Physical Laboratory, where I found that work was being done on the actual verification of manufacturing and inspection gauges; this work, of course, deals with the subject in an enhanced degree—squared, so to speak, because there is not only to be considered the tolerance of the work, but also the tolerances on both the go and the not-go gauges which are to check the work.

From internal evidence of the gauge drawings, it looked as if some of the tolerances were assigned much closer than should be necessary, and I started to try to find out how they had been fixed. To accomplish this, on every occasion when I met an engineer I asked him how he decided the tolerances in his branch of the subject; I fear I bored a great many people at this time. I got a variety of answers which sometimes explained things a bit, but often not at all, and though I discussed it with quite a number of men, many of them occupying prominent places in different branches of the profession, I came away with the impression that scarcely any of them were really interested in the subject of tolerances. To exaggerate the picture which I got as the result of my inquiry, I concluded that in designing a new machine the chief engineer drew it free-hand with dimensions to the nearest inch, and sent it to the draughtsman to work out the detail to the nearest thousandth, who then gave it to his junior assistant to mark in the tolerances. Instructions were certainly always given that tolerances should be as easy as possible, but only lip service was done to them, and the junior assistant, anxious not to get himself into trouble, would, as a general rule, think of the smallest number he knew and then halve it. This is a caricature, of course, and has some of the absurdity of one, but also perhaps just a little of the resemblance. Seriously, it seemed to me that there was a defect in the habit of thought of many in the engineering profession, and that some sort of campaign was needed to inculcate in people's minds the idea that every number has a fringe, that it is not to be regarded as exact but as so much plus or minus a bit, and that the size of this bit is one of its really important qualities.

Without any very clear idea of where to catch hold of the subject, I had full intention of trying to do something about it at the time I went to the United States a year ago. There I came across the method of 'statistical control' of mass production, and it was obvious at once that this is the right approach. Similar work has been done in Great Britain too, in particular by the staff of the General Electric Company and by members of the Royal Statistical Society, and it was perhaps ill-luck that I never came across it before crossing the Atlantic; but that I did not shows that it was not very widely known. I would add that it is not by any means very widely used yet in the United States, though the use is spreading. In both countries it has been principally used in industries associated with electricity, such as the telephone industry, but I want to emphasize that it should be of even greater importance in the mechanical industries, and that it is specially applicable to a business like the manufacture of munitions in all their aspects.

One of the important points in the new method is that it gives reasoned instead of guessed values to the tolerances. I will take as an example the making of time fuses for anti-aircraft, and I am giving away no military secrets in doing so, since I shall invent the data and miss out a lot of other considerations that would really enter. Suppose that the lethal area of a bursting shell is such that, if it explodes within a tenth of a second of the set time, it will make a kill. The gunner therefore demands of the manufacturer that he make a fuse with accuracy a tenth of a second. The manufacturer works out his method, but finds that whereas it is easy to get one to a fifth of a second, he will have a lot of trouble to get to a tenth, and, indeed, he estimates that for the same effort of work and cost he could not hope to get more than a quarter as many fuses if they must have the accuracy of a tenth. Now half his shells will burst within the range I asked for and so, in fact, I shall be wise if I accept his inferior fuse, since I shall thereby get four times as many shells of which half will do what I want, and I shall therefore double the rate of killing. I need not say that I have over-simplified the business; on one side I have missed out the cost of the other parts of the shells, and on the other, I have forgotten that the gunner has uncertainties of range to consider, so that his demand for a tenth of a second is more exact than he can justify for practical use.

My example is intended to show that it is good business for the user and the maker of any article to get together before deciding the tolerances of manufacture. The user may be inclined at first to feel that in doing this he is surrendering some of his freedom of choice, but if you consider it closer you will see that this is not so. He has not got any real freedom of choice, since he must surely try to design the article so as to be as easy to make as possible, but he has foregone the quantitative information of what will in fact prove to be easy, and above all of what thing, easy to make, will be good enough for the job. I may summarize this aspect of the matter by saying that the user has tended to demand that everything should be made for him as well as possible, but he ought to want everything to be made for him as badly as possible, or perhaps not quite that, but as badly as permissible. It is in this aspect that statistical control specially gives the right information.

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* From a paper before a joint meeting of the Institutions of Civil, Mechanical and Electrical Engineers held on April 15.

There are a good many varieties of procedure called for in the circumstances of applying statistical control. First, there are the two classes according to whether it is a quantity or a quality that is concerned. It may be a measure, say, of a length or perhaps an electrical resistance, which has to fall within certain prescribed limits; for this we can measure each specimen and record it for analysis. In other cases the test is qualitative, in that the specimen either passes a test or fails to pass—for example, a vessel is watertight or not; and even the measure of a length may fall in this class if it is tested with a gauge, so that the answer is given in the form that it passes or fails to pass the gauge. Then there is another distinction that divides either type of work into two classes. Some tests, such as a measure of length, can be applied to every article made, but other tests are destructive of the specimen; for example, the test of the force of an explosive or of the tensile strength of a bar. In this last case the test must of necessity only be done on a sample, and it is obviously important to take the sample as small as permissible. Moreover, even in the case where every specimen could be tested, there will be great economy in only doing it for a sample; so that, in fact, we may reckon that sampling is one of the main features of the process, and to determine the advisable fraction of the whole number that must be sampled is an important part of the duty of the statistician. Then again the practical problem of statistical control itself falls into two parts, for there is first the business of starting a new process and getting it into statistical control, and then the business of carrying it on later, after the control has been established. All these matters are described in the British Standards Institution publications B.S. 1008 and 600 (revised), but I shall content myself with giving a very crude sketch of a single example.

The example I shall take is based on one I learnt about in the United States, and I am intentionally leaving the details incorrect and falsifying some of the facts. I learnt about it from Colonel Simon, who has shown great brilliance in developing the methods for munitions in the U.S. arsenals. The subject was a particular type of time-fuse, and the gunners had assigned certain limits of tolerance which are described in the diagram (Fig. 1). The manufacturers all had great trouble in satisfying the demand for the longer times, so that the tolerances were exceeded both above and below, and Simon was called in to set the matter right. This he did, but to simplify the story we will imagine he had been in at the start, and describe how the process might have gone. It is first necessary to be sure that the process is 'in control', in the technical sense of the term. We take a considerable batch of the fuses, keeping them sorted according to time and place of manufacture. Group these sets (or probably samples of them) in batches of five and set the fuses at 20 sec. Time each fuse, and work out the mean of each batch and its 'range', that is to say, the difference between the shortest and longest among the five. These are marked on two charts in a way described on the British Standards Institution publication (Fig. 2). From the 'range' chart it is possible with the help of tables that have been constructed by statisticians to draw on the other a pair of limits within which the dots should fall. Perhaps they will not do so; say the dots for fuses made by one particular tool fall outside. This gives sure knowledge that something is wrong with the process—the statistician cannot say what, though I was told of cases where he could go so far as to say either that there was only one thing wrong or else certainly several things wrong. It is for the engineer to re-examine his process and find the fault. Next, of course, similar work must be done at the other fuse settings. Suppose this has been done, and that the whole system is in control, and that the accuracy is good enough for the user. After this, much less sampling is needed, but every so often a group should be taken and tested in the same way; I will not go into detail, but this sampling will nearly always give warning of pending trouble, before the trouble is so bad that the fuses would actually fail in passing their test.

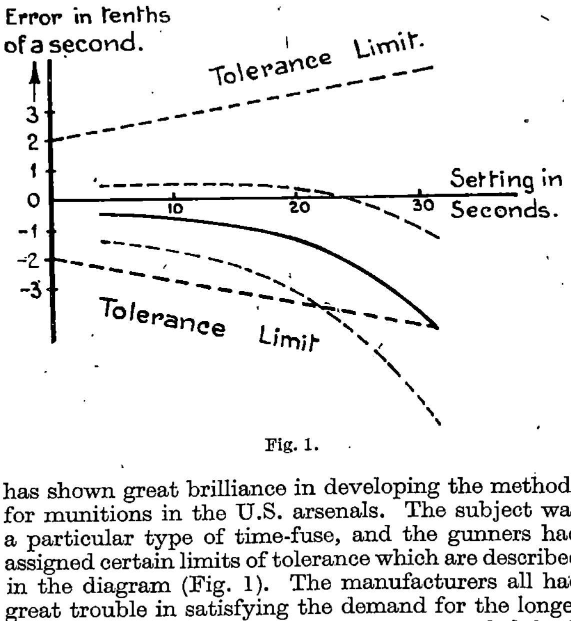


Fig. 1.

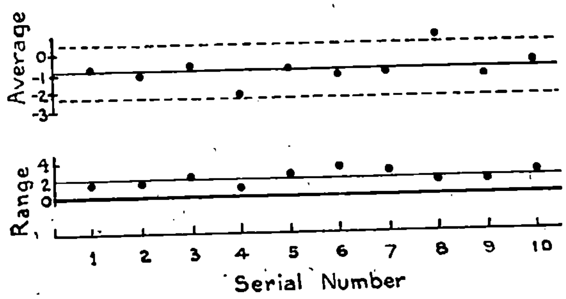


Fig. 2.

Returning to the actual history of these fuses, Simon plotted average time and 'range' for batches of five fuses at various timings of the fuse, and got the curves I show (Fig. 1) for the average timing and for the dotted lines on either side between which all values will fall. This was for the fuses of one manufacturer, and there were similar curves, some up and some down, for the others. It will be seen that the fuses mostly failed to fulfil specification at 20 sec. and above, and yet their tolerance was much finer than that which had been specified. This could be overcome in a variety of ways; for example, by regraduating the markings of the time on the fuse. The result was thus that an article which systematically failed to pass its test, was, with a quite trivial change, found to be actually better than had been asked for. I may add that as a consequence of his work Simon found that the old tests had destroyed something like twice as many of the fuses as is now necessary.

I will conclude with a few general remarks. When I first came across the method I knew it was of the greatest importance, but I doubted if the middle of a war was the time to start it. I asked this very question of two of the experts in the Bell Laboratory, and both contradicted this first thought of mine and said that it could be applied piecemeal to one process after another without delay in production. Then, as showing how quickly people could adapt themselves to it, I may recount an incident I experienced. Immediately after visiting Colonel Simon, I happened to be at Frankford Arsenal, which in peace-time was the principal factory making ammunition for the U.S. Army. As such, I expected it would be rather conservative and that it might be suspicious of new-fangled methods, and I therefore asked one of the chief colonels there what he thought of these methods, which, I may emphasize, are quite new in their application to military stores. His reply was that it seemed the only sensible way of doing the business.

Another point well worth consideration is that many works have already existing a mass of data of the kind used by the statistician, but they do not submit them to the same analysis. In such cases the change of procedure would be only slight, and a greatly improved control would be obtained by applying the statistical method.

Thirdly, the method gives information about the size of sample that should be tested. In some cases it may be inadequate, whereas in others it will be found that testing a much smaller sample would give sufficiently reliable information on the quality of the whole.

We cannot, of course, expect that the method is a panacea for all troubles, and I expect in some cases it will be tried and prove unsuitable; but I will venture the forecast that the opposite will much more often be the case, and that many processes to which at first sight it seems inapplicable will later be found to benefit greatly by the introduction of statistical control.

OBITUARIES

Mr. W. P. Pycraft

WILLIAM PLANE PYCRAFT, who died on May 1, was a well-known ornithologist and comparative anatomist. He was born at Great Yarmouth in 1868 and while a schoolboy was attracted to natural history by the wild life of the Norfolk Broads. He became a keen observer of all living things, but devoted himself specially to birds. After leaving school, he desired to follow natural history as a profession, and started as a private pupil with the curator of the Leicester Museum, where he learned the art of preserving and preparing animals for study and exhibition. In 1892 he was introduced to Prof. (afterwards Sir) Ray Lankester, who invited him to be his assistant in making preparations for the Oxford University Museum. While thus occupied he attended Lankester's lectures and demonstrations, and thus extended his outlook by acquiring a good knowledge of the structures and relationships of animals. When Lankester was appointed director of the British Museum (Natural History) in 1898, Pycraft accompanied him to London and became his temporary assistant there. Soon afterwards he joined the permanent staff of the Zoological Department of the Museum, where he remained as an assistant until his retirement in 1933. He spent his later life at Longcross near Chertsey, Surrey, in surroundings where he could continue the field observations which he had begun in early youth.

The original researches carried out by Mr. Pycraft were concerned chiefly with the anatomy of birds. His first paper, published in the *Ibis* in 1895, described and discussed the arrangement of the feathers in the Tinamous, and in 1898 he contributed a memoir on the feathering of the owls to the *Transactions of the Linnean Society*. Between 1898 and 1907 he wrote a valuable series of nine papers on the osteology of birds published in the *Proceedings of the Zoological Society*, and in 1900 he discussed the morphology and phylogeny of the Palæognathæ and Neognathæ in an extensive memoir in the *Transactions* of the same Society.

Mr. Pycraft also began to take much interest in the variations of the human skull, and in 1915 he proposed to substitute for the Frankfort base-line another line which passed wholly through the cranium avoiding the upper part of the face. This proved to be not generally acceptable, and he returned to the subject in a paper in *Man* in 1925. He wrote several accounts of human skulls, the most noteworthy being his description of the Boskop fossil from South Africa in the *Journal of the Royal Anthropological Institute* of 1913, and a description of the Rhodesian fossil skull in a British Museum volume in 1928. He took part in several discussions on the Piltdown skull, and in 1917 published in *Science Progress* an account of the lower jaw which pointed out its differences from the jaw of an ape.

Mr. Pycraft was also a prolific writer of popular books and articles on natural history, which brought him a large correspondence and not infrequently led to the discovery of new facts. His first popular books were the small "Stories of Bird Life", "Fish Life" and "Reptile Life", published by Newnes in London between 1900 and 1905. "A History of Birds", a more serious work, appeared in 1910, and his "Birds of Great Britain" followed in 1934. His volumes on the "Infancy of Animals", "The Courtship of Animals" (1913) and "Camouflage in Nature" (1925) are especially readable and contain original observations. His weekly article in the *Illustrated London News* was a much-appreciated feature of this paper for many years, and attracted wide attention.

In all his writings Mr. Pycraft showed great interest in the possible mode of evolution of the various structures and habits which he described, and an address on "Some New Aspects of Evolution" which he delivered to the Norfolk and Norwich Naturalists' Society in 1935 was reprinted in the annual report of the Smithsonian Institution, Washington, in the following year. His style was sometimes forceful, for when he had formed an opinion he could not readily be persuaded that it might be mistaken; but he had a versatile mind and was always inspiring. He is mourned by a large circle of friends who learned the more to appreciate him the closer they were associated with him.

A. S. WOODWARD.

WE regret to announce the following deaths:

Prof. Charles Cohen, formerly of the Brussels Pasteur Institute, aged sixty-one.

Dr. R. L. Ditmars, the distinguished herpetologist, formerly curator of mammals and reptiles in New York Zoological Park, on May 12, aged sixty-five.

Dr. Bernhard Fischer-Wasels, professor of morbid anatomy at Frankfort-on-Main, president of the German Pathological Society and editor of the *Frankfurter Zeitschrift für Pathologie*, aged sixty-five.

Sir James Larmor, F.R.S., formerly Lucasian professor of mathematics in the University of Cambridge, on May 19, aged eighty-four.

Prof. B. Malinowski, professor of anthropology in Yale University, formerly University professor of anthropology in the London School of Economics, on May 16, aged fifty-eight.

Dr. C. Hart Merriam, founder in 1885 and until 1910 chief of the United States Bureau of Biological Survey, now known as the Fish and Wild Life Service, on March 19, aged eighty-six.

Dr. John Miller, director of aircraft production (factories), formerly chief engineer, London and North-Eastern Railway (N.E. Area), on May 16.

The Rev. T. E. R. Phillips, a past-president of the Royal Astronomical Society and of the British Astronomical Association, on May 13, aged seventy-four.

Dr. G. G. Stoney, F.R.S., who for many years was associated with C. A. Parsons and Co. Ltd., particularly in connexion with the development of the steam turbine, on May 15, aged seventy-eight.

Prof. G. A. Witherington, formerly professor of mathematics in the Royal Naval College, Greenwich, on May 1, aged sixty-nine.

Prof. W. J. Young, professor of biochemistry in the University of Melbourne, aged sixty-three.

NEWS and VIEWS

World Mineral Resources and Post-War Needs

In the fourth clause of the Atlantic Charter, Mr. Roosevelt and Mr. Churchill state "that they will endeavour, with due respect for their existing obligations, to further enjoyment by all States, great or small, victor or vanquished, of access, on equal terms, to the trade and to the raw materials of the world which are necessary for their economic prosperity". The Division for the Social and International Relations of Science of the British Association is therefore arranging a conference on "Raw Materials and Industrial Needs: Mineral Resources and Outlook", to be held in London at or about the end of July. As Sir Richard Gregory, president of the Association, pointed out in submitting the proposal for such a conference, the world's natural resources—both organic and inorganic—are much too large a subject to be dealt with in a single conference, but a survey of the present position of minerals of industrial importance, with suggestions for further investigations into their geographical distributions and research into the production of substitutes, will show the close contact between science and fundamental national and international problems. The Conference will indeed be similar to a joint meeting of the Sections of Geology, Geography, Physics and Chemistry at an annual assembly of the British Association, and its papers will be of the nature of contributions to a report upon the distribution, output and industrial uses of the chief mineral deposits of the world. Such energy resources as solid, liquid and gaseous fuels belong to a class of their own, and the facts relating to them have been brought before a number of World Power Conferences. Whatever is known about the nature, distribution and uses of minerals in the earth's crust has been gained by scientific inquiry, and the knowledge is international in origin and scope. By presenting the chief facts as to natural resources of minerals and their geographical control, such a conference can do much to promote recognition of the interdependence of nations and the need for collaboration between them.

Scientific Workers of the Argentine

During last March, Prof. E. D. Adrian, professor of physiology in the University of Cambridge, paid a visit to the Argentine at the invitation of the Argentine National Academy of Medicine. He was welcomed with much cordiality and was frequently assured of the sympathy of Argentine medical men and scientific workers for the Allied cause. Towards the end of his visit, Prof. Adrian was asked to receive a deputation from the Comisión Sanitaria Argentina de Ayvda a las Democracias (Health Committee to Aid Democratic Countries). This deputation asked Prof. Adrian to convey a message of solidarity to members of the medical profession and scientific men in Great Britain. The Committee said that the example set by British men of science working in their laboratories and clinics, holding congresses even in war-time to promote the application of scientific discovery to the progress of mankind, and arranging the co-ordination of the scientific work of Great Britain, the U.S.S.R. and the United States, strengthens their faith in the triumph of democracy through science. This very cordial message from the Argentine will be received with much satisfaction by scientific workers in Great Britain, who will be encouraged to pursue the course they have set for themselves in helping to rid the world of totalitarianism.

Illuminating Engineering Society

At the annual general meeting of the Illuminating Engineering Society on May 12, Mr. W. J. Jones (president) was able to present an encouraging record for the past session. A feature has been the further development of centres and groups, of which there are now eleven, and which are expected to do useful work in studying the lighting requirements of special local industries. The position in regard to the Society's work on A.R.P. lighting, undertaken jointly with the Ministry of Home Security, has for the time become stabilized, but a number of committees are now exploring various aspects of lighting in relation to after-war reconstruction. The "Recommended Values of Illumination" put forward by the Society (I.E.S. Code) has been adopted by the Ministry of Supply, the Admiralty and the Ministry of Aircraft Production, in applying the Factories (Standards of Lighting) Regulations (1941). Many members of the Society are engaged in the task of designing lighting installations for factories engaged on national work. The Society in 1940 initiated the practice of conferring fellowship on those of its members having the requisite technical qualifications. The number of fellows created is now 96—rather less than ten per cent of the membership of the Society. The new president for the forthcoming session is Mr. R. O. Ackerley.

The Illuminating Engineering Society made a practice, in the years preceding the War, of inviting an eminent expert from abroad to deliver an address on the occasion of each annual meeting. This practice is no longer possible in the present circumstances, but its own members have filled the gap. The lecturer on May 12 was Mr. G. H. Wilson, who took for his subject "Street Lighting: Past, Present and Future". Mr. Wilson remarked that the period 1928–38 was one of great technical progress. An outstanding event in 1928 was the erection of fifty model lighting installations illustrating the eight classes of the British standard specification. This led to a recognition of the importance of road surface brightness as a factor in relation to visibility. During the ten-year period two new sources, the sodium and mercury vapour lamps, were introduced. Their unusual spectra raised new problems and their shape and size made necessary considerable changes in the design of lanterns. Attention was also devoted to the problem of the siting of posts, which was discussed in the report of the departmental committee appointed by the Ministry of Transport appointed in 1934. After referring briefly to lessons to be learned from our experience of the low orders of illumination available during the present black-out, Mr. Wilson reviewed after-war problems. He pointed out the possibilities of the new fluorescent lamps, expressing the belief that technical resources are enormous. The future of street lighting, he affirmed, depends largely on the extent to which the scientific attitude of mind is employed in the application of the achievements of research—for example, in connexion with bold experiments in town planning.

Fluorescent Lighting

A paper on this subject, read recently by L. J. Davies, H. R. Ruff and W. J. Scott before the Institution of Electrical Engineers in London, gives a brief history of fluorescent lighting and follows this by a description of a typical mains-voltage tubular fluorescent lamp and the principles of its operation. The new fluorescent lamp combines the high efficiency of the straight electric discharge lamp, with much of the convenience of operation of the incandescent lamp, while possessing, in addition, special characteristics of low brightness, exceptional colour-rendering power, and comparative absence of radiant heat. The 200/250-v., 80-watt lamp and its auxiliaries, marketed in Great Britain in March 1940 to improve factory lighting in blackout conditions, are described in detail and the characteristics and components of the complete unit are explained. This lamp is 5 ft. long and 1½ in. in diameter, taking 0·8 amp. at a lamp voltage of 115; its nominal luminous efficiency is 35 lumens/watt and its mean brightness is 3·3 candles/sq. in. Its high electric power/light conversion ratio is examined together with the conventions whereby these are assessed. The paper concentrates attention upon the practical features of the lamp, but gives a sufficient description of the physics involved to promote an appreciation of both the present characteristics and future importance of this type of light source. The authors conclude that the lamp is satisfactorily fulfilling a present industrial need, and that its quality has been so greatly appreciated that it is undoubtedly the forerunner of a new series of lighting lamps.

Industry in Scotland

In the discussion in committee in the House of Commons on May 12 on the estimates for the Scottish Home Department, Mr. T. Johnston, Secretary of State for Scotland, gave a survey of industrial development in Scotland since 1918. He referred to the advisory committee on Scottish industry which has been set up, and expressed the hope that by its means the industrial aftermath in Scotland of 1914–18, due to concentration on heavy industries for export, will be avoided. In the course of the discussion, Sir John Graham Kerr put in a plea for the development of a variety of small light industries. The industrial belt of Scotland has grown in its present position because the sources of power are close at hand. Industry tends to drift to the more populous parts of the country—in Scotland to the south—and one way of stopping this drift is to carry power all over the country. The transport of power is of vital importance. In the form of coal and oil, subject to road or rail transport, power is only distributed with difficulty and at relatively high cost. The newer method of distribution of power through an electric grid might have a tremendous influence on Scotland and its industries, for, by these means, the site of industry is no longer tied to the source of power, and the feeding of small units becomes feasible.

Austrian Scientific Workers in Great Britain

An Association of Austrian Engineers, Chemists and Scientific Workers in Great Britain has recently been formed. The main activities of the Association will be to assist members in their professional work and interests, to represent them with the authorities, to promote contact and relations with British colleagues and to form a link with British scientific and technical institutions. Lectures, courses and discussions will be held and will give opportunities for the exchange of views and to discuss matters of mutual interest. It is hoped that the Association may assure that better use is made of the knowledge and abilities of Austrian engineers, chemists and scientific workers who are anxious to assist in the war effort. The acting chairman of the Association is Dr. F. Ehrenfest-Egger; inquiries should be sent to the honorary secretary, Mrs. K. Hilfreich, 133 Hatherley Court, London, W.2. Lectures are being given on the first Monday of each month. Every Monday, commencing June 1, at 7 p.m., a club-room will be open for members of the Association at the Austrian Centre, 69 Eton Avenue, N.W.3, where there will be opportunities to read technical periodicals and to meet other colleagues.

A Relic of Dr. John Dee

The sale by Messrs. Sotheby of an interesting relic of the mathematician and astrologer Dr. John Dee, who was patronized by Queen Elizabeth, was recorded in *The Times* of May 5. The relic is a gold disk 3½ in. in diameter weighing 1 oz. 4 dwt. 5 gr., bearing the London date letter for 1589 and engraved with a diagram of the "Vision of the Four Castles" which appeared to his medium Edward Kelley, on the morning of June 20, 1584, at a house in St. Stephen's Street, Cracow, where the two men were staying. The diagram is reproduced in "A True and Faithful Relation of what passed for many Years between Dr. John Dee . . . and some Spirits" published in 1659 by Dr. Meric Casaubon. The disk was bought by the British Museum for £230.

Institution of Electrical Engineers Awards

THE Council of the Institution of Electrical Engineers has made the following awards of premiums for papers read during the session 1941–42, or accepted for publication: *Institution Premium* to Mr. J. M. Meek; *Ayrton Premium* to Mr. J. S. Forrest; *Fahie Premium* to Dr. W. G. Radley and Mr. E. P. G. Wright; *John Hopkinson Premium* to Dr. A. L. Williams and Mr. L. E. Thompson; *Kelvin Premium* to Mr. E. Colin Cherry; *Overseas Premium* to Prof. K. Aston and Mr. M. V. Kesava Rao; *Extra Premiums* to Dr. A. H. M. Arnold, Mr. G. W. Bowdler, Messrs. G. W. Bowdler and W. G. Standring, Mr. R. Davis, Dr. H. D. Einhorn and Prof. B. L. Goodlet, Dr. Hackett and Mr. A. M. Thomas, Mr. E. A. Richards, Mr. V. Sia, Messrs. R. C. Woods and A. S. MacDonald; *Installations Section Premiums* to Messrs. L. J. Davies, H. R. Ruff and W. J. Scott (Crompton Premium), Mr. R. Grierson; *Meter and Instrument Section Premiums* to Messrs. E. A. Burton, J. S. Forrest and T. R. Warren (Silvanus Thompson Premium), Mr. D. J. Bolton; *Transmission Section Premiums* to Mr. J. W. Leach (Sebastian de Ferranti Premium), Messrs. W. Casson and F. H. Birch; *Wireless Section Premiums* to Mr. O. S. Puckle (Duddell Premium), Dr. D. C. Espley and Mr. D. O. Walter (Ambrose Fleming Premium), Messrs. J. E. Thwaites and F. J. M. Laver.

Earthquake in Ecuador

REPORTS have been received from Guayaquil, the chief port of Ecuador, that a severe earthquake took place in the interior on the night of May 13–14. Guayaquil itself was severely shaken for some 60 seconds according to human perception, and buildings collapsed. It is estimated that about sixty people lost their lives. Mr. J. J. Shaw's seismograph at West Bromwich recorded a severe earthquake at 2h. 25m. 52s. U.T. on May 14. Further news is awaited. It will be recalled (NATURE, Feb. 11, 1939, p. 238) that several earthquakes shook a considerable area in Ecuador including the towns of Vallechillos and Quito on the night of February 1, 1939. On that occasion the volcano Cotopaxi erupted.

Earthquakes Registered at Kew

Two strong distant earthquakes have recently been recorded at Kew Observatory. The first, on April 8, 1942, began recording on the vertical component at 15h. 53m. 58s. U.T. impulsively, and on the N and E components at the same time P was emergent. The shock probably originated some 11,000 km. distant, at maximum attained an amplitude of 410 μ at Kew, and finished recording at 19h. 20m. U.T. The second, on April 13, began recording impulsively on all three components at 07h. 55m. 48s. U.T. from an epicentral distance of 6,130 km., attained a maximum amplitude of 94 μ and finished recording at 10h. 00m. U.T. All readings are tentative.

Between April 15 and May 5 eighteen earthquakes were registered by the seismographs at Kew Observatory. All these shocks gave rise to small amplitudes with the exception of the earthquake of April 20. This began recording at 08h. 52m. 40s. U.T. and finished recording at 10h. 25m. U.T. The interpretation of this record is at present tentative, though an epicentral distance of 125° is possible.

The Ipswich Man

THE skeletal remains known as the Ipswich man, which have been housed at the Royal College of Surgeons, London, since they were discovered in Bolton and Co's brickfield, Ipswich, in 1911, have now, through the instrumentality of Mr. Reid Moir, and the kindness of the president and Council of the College, been presented to the Ipswich Museum. Since 1911 a great deal has been discovered regarding the age of these remains, which were thought originally to be older than the Upper Chalky Boulder Clay—a deposit of one of the major glaciations of East Anglia. It now seems clear that the skeleton is referable to one of the prehistoric floors situated in the slopes of the adjacent valley, and examples of flint implements, etc., found in these floors are exhibited with the human bones in the entrance hall of the Ipswich Museum. Though all the geological and archæological aspects of this matter are not yet completely understood, it is highly probable that the Ipswich man lived in the earlier part of Upper Palæolithic times, and is of considerable antiquity.

Announcements

PROF. E. H. ALTON, registrar and professor of classics in Trinity College, Dublin, who represented the College in the Dail from 1923 until 1937, when the University representation was abolished and he was elected to the Irish Senate, has been appointed provost of the College in succession to the late Dr. W. E. Thrift.

MR. HARRY BREARLEY, the well-known steelmaker of Sheffield, has been elected to honorary membership of the Iron and Steel Institute. Mr. Brearley's recently published autobiography was reviewed in NATURE of April 11, p. 397.

THE British Standards Institution has been recognized by the Government as the sole organization for the issue, in consultation with any Government, professional or industrial bodies concerned, of standards having a national application. In regard to the preparation and issue of codes of practice for building and civil engineering work, the Minister of Works and Buildings is making special arrangements by the appointment of a representative committee with which the Institution is co-operating.

As from the commencement of next session, the name of the Meter and Instrument Section of the Institution of Electrical Engineers will be altered to "Measurements Section". The Section will include within its scope all matters relating to electrical measurement and control, the design and application of the apparatus, and the materials employed in connexion with them.

A DISCUSSION on "Soviet Metallurgy", arranged by the Faculty of Science, Marx House, will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, on May 28 at 7 p.m. The discussion will be based on a paper by Mr. Tom Barker, who took a leading part in the creation of the great Kuzbas Metallurgical Combine in Siberia. Tickets of admission, including a copy of Mr. Barker's paper, can be obtained from Marx House, Clerkenwell Green, London, E.C.1, price 2*s*.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Cosmic Rays and Magnetic Storms

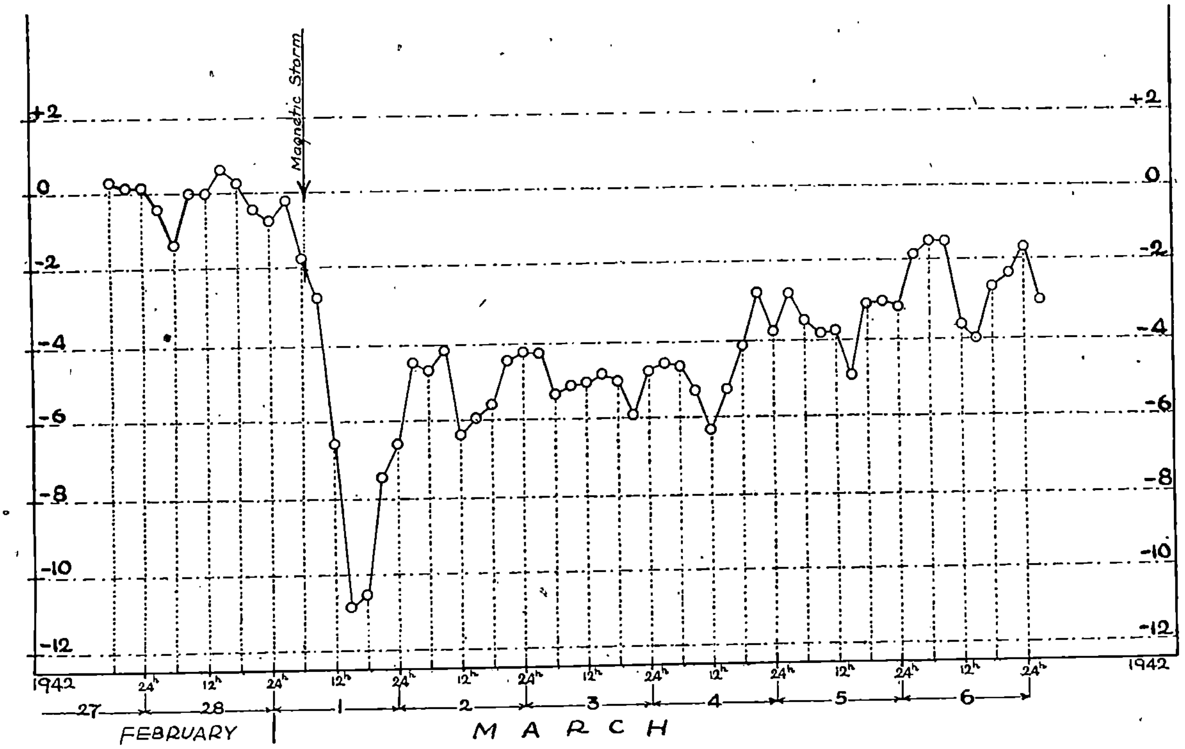
HOURLY records of the intensity of cosmic rays have been made during the past year. The apparatus used consisted of a battery of Geiger counters registering about 25,000 threefold coincidences each hour. The circuit used gave a negligibly small number of casual coincidences. No absorbing screens were used, but preliminary experiments with lead showed that the thickness of the counter walls was sufficient to cut out all radioactive rays and the very soft cosmic rays. To count such a rapid rate of coincidences without loss, a Wynn-Williams' scale-of-two counter[1] was used. For this circuit the resolving time is so reduced that, at the counting rate of 400 per minute, the number of particles which is missed is not more than one per thousand. The number of pulses recorded by the telephone counter is photographed automatically every hour.

The whole apparatus was prepared in the Physical Laboratories at the University of Manchester, and the observations are being made in a room at the top of the Imperial College of Science, South Kensington.

The observations began in February 1941, but the photographic recording started only in April. The first phenomenon to which attention was given was the so-called temperature effect of cosmic rays, not only because of its importance in itself, but also so as to be able to eliminate this influence from the observations and thus to establish more accurately the other time variations. A detailed account of the results of the work will be given elsewhere. It will be shown that the changes from day to day in cosmic rays, when corrected for changes in atmospheric absorption, are well correlated with the variations in height of the atmospheric layer of given pressure at which mesons are supposed to be formed. This is consistent with Blackett's explanation on the basis of the instability of the meson.

When this effect is eliminated from the observations, then the well-known world-wide changes appear which are associated with the disturbances of the terrestrial magnetic field. These changes are being studied in detail.

In this letter an account is given of the remarkable changes of cosmic ray intensity associated with the magnetic storm of March 1, 1941. The figure shows the observed time variation from February 27 to March 6. The decrease of nearly 12 per cent on March 1 is certainly unusually great, and, so far as is known to us, is the largest variation of this kind so far recorded.



PERCENTAGE DEFICIENCIES OF COSMIC RAYS DURING FEB. 27–MARCH 6.

The points on the diagram represent the mean value of the cosmic ray intensity during a period of three hours. The scale is in percentages from the normal value. The cosmic ray disturbance began shortly before the onset of the magnetic storm. From information kindly given by the Royal Observatory, the latter began at 7h. 27m. on March 1. Allowing for the statistical fluctuations (± 0·36 per cent for the three-hour period), it appears that the cosmic rays disturbance began about one hour earlier. The storm subsided rapidly after 1 a.m. on March 1 and finished three hours later. After the first rapid recovery of about half the initial drop, which occurred within twenty hours of the onset, the recovery was very slow and was not complete by the sixth day.

It is remarkable that the magnetic storm was not so intense as some others which have been accompanied by a less violent disturbance in cosmic rays. The extreme range in the horizontal magnetic force H was $512\,\gamma$, equivalent to less than 3 per cent of the H value. Nevertheless, it appears that the bright eruption which began to be observed on the sun 19h. 27m. earlier was one of the most extensive recorded, lasted for an unusually long time and produced a much larger magnetic effect than usual. Also a special feature of the storm was a series of 27 giant pulsations in H and V which lasted from 15h. 5m. to 17h. 3m. on March 1, and are, it seems, unique in the Abinger records. It was just in this interval when the number of cosmic particles reached its lowest value. The mean of the two-hourly observations centred at 16h. and 17h. represents a decrease in this number of 12·0 ± 0·44 per cent.

From the record of this and other storms, it seems clear that, at any rate in these latitudes, there is no simple proportionality between geomagnetic and cosmic rays disturbances.

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[1] Wynn-Williams, C. E., *Rep. Prog. Phys.*, 3, 239 (1937).

Dispersion of Cellulose Strands in Cell Walls

In a recent letter in NATURE[1] Prof. Frey-Wyssling directs attention to the importance in cell wall studies of the *angular dispersion* of the constituent cellulose micelles and refers to my papers as ignoring this property. Cell wall physics is a study in which there is already much controversy, and it seems therefore a pity to give the impression of a difference of opinion where none actually exists. The question centres round the desirability of taking into account not only the 'parallel' texture said to be typical of fibres but also the so-called 'dispersed' or 'reticular' texture present in some other cell types. So far as I am concerned, the difference between 'parallel' and 'dispersed' textures is one of degree only and actually, far from taking ". . . only parallel textures into account . . .", I have yet to investigate a single cell in which I am convinced that this texture does occur in anything like a strict sense. In some fibres[2] and wood cells[3], for example, where Frey-Wyssling himself supports parallel texture, and in some collenchyma[4], my collaborators and I have shown that the angular dispersion of the cellulose micelles about the extinction direction may be considerable and is probably of importance in explaining certain optical properties of the wall. These latter papers have apparently not been available to Prof. Frey-Wyssling since his citations of my papers cease in 1939.

In the paper from which he quotes, however, I made the first suggestion, later applied also to the conifer tracheid[3], that certain optical properties are to be explained in terms of the angular dispersion of the cellulose matrix. In cross-section the walls of some of the cells referred to (vessels of some ring-porous trees) show optical discontinuities, and concerning the explanation of this fact I remarked: ". . . the observed phenomena may be accounted for either by a variation in chain direction from layer to layer, by a variation in chemical nature, by 'a change in the *dispersion* of a single direction', by a variation in the amount of cellulose present in the crystalline phase, etc. Any one of these possible causes 'may be accepted only when the others have been ruled out'." The sections quoted by Prof. Frey-Wyssling (enclosed in single inverted commas) are therefore misleading. The full quotation, and even more strongly the sense of the whole paper, makes it abundantly clear that here I am questioning not the existence of dispersion or even of changes in dispersion but whether these can explain the phenomena under review. In fact the purpose of this paragraph was to emphasize what I have repeatedly said elsewhere—that the *angular dispersion* of the cellulose in a wall should not be overlooked in studying its optical properties.

In several places[6] I have directed attention to the dangers involved in the interpretation of optical properties, and particularly of extinction directions, when unsupported by other evidence and it comes therefore as a surprise to find myself indicted for failing to observe my own precepts. On the other hand, while it is clear that the cellulose of most, if not all, cell types is to be thought of as 'dispersed' rather than 'parallel' in the strict sense, it seems to me a natural and legitimate simplification, in making preliminary calculations such as I have presented, to take the extinction direction of a wall of the 'dispersed' type as a hypothetical unique 'cellulose chain direction'. In most cases the modifications to be expected in adding the dispersion around the extinction direction to the resulting figures are of secondary importance only, and may be considered at a later date as the opportunity and necessity arise. Admittedly, there are some cases where this assumption cannot safely be made—cases where the dispersion itself is of vital importance—and one of these I propose to examine elsewhere in the near future, but generally in geometrical considerations of growth problems where I have used this simplification I maintain that it is fully justified.

With the statement of Prof. Frey-Wyssling that the dispersion can be measured most readily from the X-ray photograph I am, of course, in complete agreement. I myself have hitherto used no method other than this, but of the available indirect methods I would prefer the fluorescence staining method of Morey[7] to the chlorzinc iodide method of Frey-Wyssling since the latter technique introduces possible changes in dispersion on swelling. I would like, however, to point out further that Prof. Frey-Wyssling is in error when he implies that no X-ray photographs are available of single cell walls. A photograph has already been published of the X-ray diagram of an oak vessel[5] and of what corresponds to single walls of a conifer tracheid, and in each of these photographs the angular dispersion can be measured approximately. Under some conditions, moreover, the dispersion can be detected and measured in some cell types even though bundles of cells rather than individual walls are photographed[4].

There is, therefore, no fundamental difference between Prof. Frey-Wyssling's attitude and mine concerning the 'dispersed' texture. The 'reticular' texture figured so often by Frey-Wyssling is, however, of a somewhat different type and I must confess some hesitation in accepting this as a possibility as it stands. That there occurs in latex vessels and in most cells with primary walls a high degree of dispersion is well established, but this by no means suggests that the cellulose complex is reticular.

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[1] Frey-Wyssling, A., NATURE, **149**, 384 (1942).

[2] Kundu, B. C., and Preston, R. D., *Proc. Roy. Soc.*, B, **128**, 214 (1940); Preston, R. D., and Allsopp, A., *Biodynamica*, No. 53 (1939); Preston, R. D., *Proc. Roy. Soc.*, B, **130**, 103 (1941).

[3] Preston, R. D., *Proc. Leeds Phil. Soc.*, Sci. Sec., **3**, 546 (1939).

[4] Majumdar, G. P., and Preston, R. D., *Proc. Roy. Soc.*, B, **130**, 201 (1941).

[5] Preston, R. D., *Ann. Bot.*, N.S., **3**, 507 (1939).

[6] Preston, R D., *Proc. Roy. Soc.*, B, **125**, 372 (1938); *Phil. Trans.*, B, **224**, 131 (1934): *Biol. Revs.*, **14**, 281 (1939). Preston, R. D., and Astbury, W. T., *Proc. Roy. Soc.*, B, **122**, 76 (1937).

[7] Morey, D. R., *Text Res.*, **4**, II (1934).

Effect of Certain Chemotherapeutic Agents on Experimental Eye Lesions produced by *Staphylococcus aureus*

THE difficulty of producing uniform staphylococcal lesions of the cornea in the rabbit, for the purpose of estimating the value of therapeutic measures, has long been recognized[1] although Brown and Pugh[2] succeeded in producing a fairly satisfactory ulcer by using a strain found after many trials.

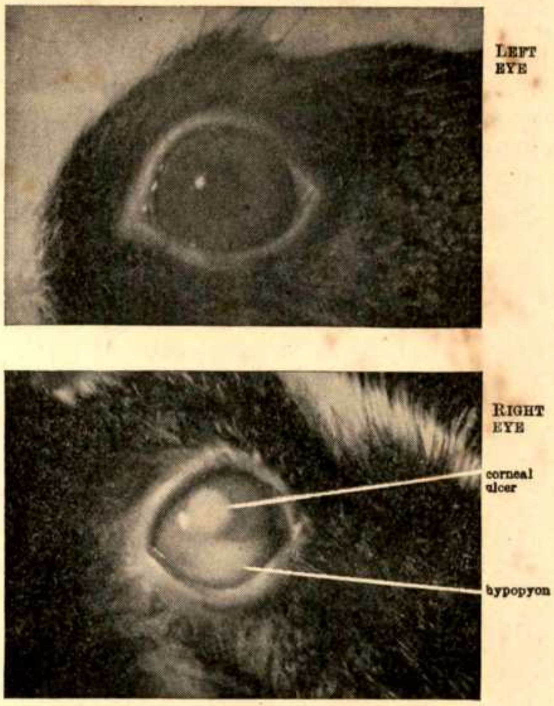
In the following experiments eight coagulase positive strains of *Staphylococcus aureus*, obtained from human lesions, were tried in preliminary tests on rabbits' eyes, and the one found to be the most virulent was used as it consistently produced a lesion. The lesions, however, were too acute and rapidly destructive when an undiluted culture was injected into the cornea, and therefore, after a number of preliminary trials, the following technique was evolved.

A 24-hour culture in broth was diluted with saline to contain 1,500 organisms per c.c., and this was injected into the cornea to make a small bleb under the epithelium. In each rabbit both eyes were so injected, and great care was taken to make these initial inoculations as equal as possible. In each animal one eye was treated with the appropriate chemotherapeutic agent, while the other eye was similarly treated with saline.

The first treatment was applied one hour after inoculation, and the treatment was usually continued at hourly intervals for the next forty-eight hours, and thereafter at less frequent intervals.

Lesions involving ulceration of the cornea invariably developed in the control eyes, and in 90 per cent of cases this was associated with development of hypopyon. In some 75 per cent of cases the ulcers were large and resulted in either extensive corneal scarring or gross destruction of the eye with or without perforation.

The lesions developed rapidly and by the end of forty-eight hours after inoculation the ulcers were already, as a rule, moderately severe and associated with hypopyon and considerable iritis.



CONDITION OF EYES OF RABBIT 494 ON SECOND DAY AFTER INOCULATION.
Left eye, treated with penicillin; right eye, control.

The following chemotherapeutic preparations were used: (1) sodium sulphacetamide (this was supplied to us as a 30 per cent solution, and was used either undiluted or diluted with saline to a 10 per cent or a 2·5 per cent solution); (2) a 15 per cent solution of solubilized sulphathiazole (sulphathiazole sodium formaldehyde sulphoxylate); and (3) solutions containing penicillin, prepared by extracting from fluid culture with amyl acetate and re-extracting into water, as described by Florey *et al.*[3]. When assayed by the methods described by these authors the solution produced an area of bacteriostasis 21–23 mm. in diameter, when tested against *Staphylococcus aureus*.

The results obtained with these preparations are shown in the accompanying table. Penicillin proved

EFFECTS OF VARIOUS TREATMENTS ON EXPERIMENTAL STAPHYLOCOCCAL LESIONS

The main subdivision has been drawn between slight and moderate, since the 'slight' lesions left scars which were small and localized and would not have seriously interfered with vision, whereas the 'moderate', and of course the more severe lesions, produced scarring which was considerably more extensive, and which would have seriously interfered with the function of the eye. The very severe lesions involved gross destruction of the eye. The figures represent the percentage of eyes, in any one group, showing the particular type of lesion.

Treatment	Lesion produced					No. of animals
	None or trace %	Slight %	Moderate %	Severe %	Very severe %	
Control	0	8	38	38	16	13
	8			92		
Penicillin	31	46	15	8	0	
	77			23		
Control	0	31	44	6	19	16
	31			69		
30% sod. sulphacetamide	19	56	19	0	6	
	75			25		
Control	0	33	33	22	11	9
	33			66		
15% sulphathiazole	11	44	33	11	0	
	55			44		

to be the most effective in the treatment of these staphylococcal lesions. It is probable that still better results will be produced with more concentrated solutions of penicillin. The result in one animal (494) is illustrated in the accompanying figure.

Sodium sulphacetamide (30 per cent) produced quite obvious beneficial effects.

Because of its known value against staphylococci, we expected very satisfactory results with the concentrated solution of sulphathiazole, but they were unfortunately disappointing.

Weaker concentrations of sodium sulphacetamide were tried in small groups of animals. The results suggest that a 10 per cent solution may perhaps be as effective as the 30 per cent solution, but the 2·5 per cent solution produced only slight benefit in the treatment of these lesions.

The preliminary reports of Florey *et. al.*[3] have already suggested that penicillin may be effective in the treatment of eye lesions. Our experimental results support this conclusion, and also offer evidence that sodium sulphacetamide may be of value in the local treatment of staphylococcal lesions of the human eye.

We should like to thank Dr. Oag, of the Department of Bacteriology, University of Edinburgh, for his advice and for supplying the cultures and dilutions used in these experiments. Mrs. MacNaughtan, of the Department of Bacteriology, University of Edinburgh, very kindly supplied us with penicillin solution. We are indebted to Dr. Prescott of Burroughs, Wellcome and Co. for the preparation of the solubilized sulphathiazole and to Mr. Edwards of British Schering, Ltd., for the supply of sodium sulphacetamide (albucid soluble).

We are grateful to the W. H. Ross Foundation (Scotland) for the Study and Prevention of Blindness, which defrayed the expenses of this investigation.

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[1] McDonald, R., and Pettit, H., *Arch. Ophthal.*, **21**, 817 (1939).
[2] Brown, A. L., and Pugh, J., *Arch. Ophthal.*, **16**, 476 (1936).
[3] Florey, H. W., *et al.*, *Lancet*, ii, 177 (1941).

Microbial Synthesis and Autolysis in the Digestive Tract of Herbivora

Both the rumen in ruminant and the cæcum in non-ruminant Herbivora support an abundant iodophile microflora : that is, an association of taxonomically diverse species exhibiting, in consequence of the deposition within them of bacterial starch or granulose, the common characteristic of giving a blue reaction with iodine.

I have established by direct microscopic observation that the iodophile micro-organisms make their appearance on the adoption by the young animal of a vegetable diet, progressively displacing the aniodophile species prevalent in the early phases of milk-feeding ; and, furthermore, that they play a determinant role in the decomposition of starch, pectins and cellulose [1,2,3].

Thus the decomposition of these substances in the rumen or cæcum is accompanied by the deposition within the micro-organisms of an iodophile polysaccharide. The opinion has been advanced, moreover, that the products of synthesis as well as the initial products of decomposition may be utilized by the host animal[3,4,5,6]. In conformance with this opinion is the fact that very few iodophile micro-organisms are found in the fæces[3,6]. It can be demonstrated that several agents may be concerned in their elimination. Thus *in vitro* experiments on centrifuged suspensions of iodophile micro-organisms from the rumen of cattle have shown that they are not acted upon by peptic and only slowly affected by commercial tryptic preparations. Observations, however, on fresh rumen contents demonstrated that they are ingested and digested in large numbers by the ciliates present (Ophryoscolecidæ and Isotrichidæ), thus confirming Westphal's results with *in vitro* cultures of rumen protozoa[7]. It was found, moreover, that the ciliates, unlike the iodophile micro-organisms, were readily acted upon by enzyme preparations. Similarly, examination of post-mortem material showed that in the abomasum the majority of the rumen Protozoa had been digested (cow and sheep). In the cæcum of the horse a digestion of bacteria by ciliates (Cycloposthidæ, Paraisotrichidæ, Butschlidæ, etc.) had also been recorded[6]. In the guinea pig, however, the Entodiniomorpha are not represented and the small flagellates present (Hexamita, Trichomonas, etc.) do not play an important part in the removal of bacteria[5]. Finally, in the adult rabbit, Protozoa may be altogether absent[4]. In these cases other agencies must be invoked to account for the observed elimination of iodophile micro-organisms. An intensive action of digestive enzymes is precluded by the position of the cæcum and colon. It had been conjectured, therefore, that in these conditions bacterial autolysis might play an important part[6]. This hypothesis has now been tested as follows :

Cæcal contents of a guinea pig were removed and a portion suspended in 10 per cent formalin (control). The remaining portion was diluted with saline saturated with chloroform and divided into two fractions. One of these was heated to 100° C. for 2 min. Both were incubated at 37° C. for 12 hr. The formalized control showed an abundant disintegration of starch grains which were entirely surrounded by iodophile micro-organisms. In the boiled fraction the iodine reaction of the iodophile micro-organisms was unchanged, whereas in the unboiled fraction it had entirely disappeared. Since the reaction of the grains was unimpaired the absence of free amylase could be inferred. The changes witnessed were, therefore, attributed to autolysis. Identical results were obtained in parallel experiments performed with rumen contents of cattle.

It is clear, therefore :

(*a*) That several agencies may co-operate to a varying degree in different Herbivora in the elimination of the iodophile micro-organisms, namely :

(1) Ingestion and digestion by Protozoa.
(2) Action of digestive enzymes.
(3) Bacterial autolysis.

(*b*) That the mode of elimination in ruminants is more complex than in non-ruminants.

(*c*) That in the simplest instance elimination may be effected by bacterial autolysis alone.

Any effort, therefore, to elucidate the complex problems concerned in the effective utilization of a particular diet must inevitably take account of the interadjustment of the processes enumerated, that is, of the actual mode of transference of the available polysaccharides from the vegetable materials ingested to the tissues of the animal. No mention has been made in this communication of the protein syntheses integral to the maintenance of a microbial population in the cæcum or rumen; nor of the initial nitrogen sources from which they may be able to proceed. A detailed study of some microbiological aspects of the problem is, however, now being made in close collaboration with the biochemical investigation of *in vitro* incubations of rumen contents in progress at the Hannah Dairy Research Institute[3,8].

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[1] Baker, F., and Martin, R., NATURE, **141**, 877 (1938).

[2] Baker, F., *Sci. Prog.*, No. 134 (Oct., 1939).

[3] Baker, F., NATURE, **149**, 220 (1942).

[4] Baker, F., and Martin, R., *Zent. Bakt.*, Ab. II, **96**, 18 (1937).

[5] Baker, F., and Martin, R., *Zent. Bakt.*, Ab. II, **97**, 201 (1937).

[6] Baker, F., and Martin, R., *Zent. Bakt.*, Ab. II, **99**, 400 (1939).

[7] Westphal, A., *Zent. Parasitenk.*, **7**, 71 (1934).

[8] Owen, E. C., Smith, J. A. B., and Wright, N. C., NATURE, **147**, 710 (1941).

Spore Dispersal in the Mucorales

THE problem of spore dispersal presented in my last communication[1] is now partially solved, as a result of spore-blowing experiments and the observation of cultures grown in cemented glass cells with coverslip surfaces.

The chief fact which emerges is that the Mucor sporangium is primarily a water dispersal mechanism, and that Mucor spores, for the most part, become airborne only after preliminary separation in water, and then chiefly on the surface of soil dust particles and hyphal fragments.

The sporangial membrane in Mucors breaks up and eventually disappears in contact with water. In Mucors with thin walls, usually described as 'diffluent' (for example, *M. hiemalis*), this process is rapid, and if the sporangium remains untouched in moist air it gives place to a conspicuous sporangial drop. The stalk on losing turgidity collapses and usually brings the drop against a solid surface, whereupon it spreads out rapidly owing to surface tension. The word 'burst' is inappropriate to describe this process. On drying down the spore masses remain firmly stuck together with mucilage which, however, is readily dissolved and the spores separated in water.

Growing on organic matter in soil the sporangiophores can be seen to form a network linking the soil particles, against which the sporangia are inevitably brought into contact at some stage, with the presumed result that the spores are dispersed by the soil water when present.

Spore-blowing experiments on this type of Mucor show them to be complete *spore retainers* in air. The function of the sporangiophore is thus seen to be that of ensuring some preliminary dispersal of the spore masses, rather than that of raising the sporangium into the air. Its sensitiveness to light in the early stages of growth may also have the effect of counteracting the down-washing of water, and raising the spore masses so as to keep them in the upper layers of the soil, where both aeration and organic matter provide more favourable conditions for the growth of Mucors.

However, when air-dried soil, which has been sterilized and then soaked in a suspension of spores of *Mucor hiemalis*, is subjected to gentle blowing, many colonies are obtained, some of which arise from visibly single spores, but the majority from soil particles, and natural soils also yield scattered colonies of diffluent-walled Mucors. The occurrence of air-borne infections by Mucors of this type is thus explained, and also their frequent presence in dust.

Some species, however, notably *M. rouxianus*, exhibit a subsidiary form of air dispersal, in that the old dry mycelial network is extremely brittle, and when blown upon fragments, yielding scattered colonies each of which is found to arise from a spore mass, or even a single spore, attached to a hyphal fragment. This is referred to as *hyphal spore dispersal*.

Mucor racemosus also fragments in this way, dispersing chlamydospores as well as attached sporangiospores. A few spore masses, without hyphæ, are also dispersed, and the stalks do not collapse so completely, so that some direct air dispersal is possible. Here the wall survives longer in contact with water, and the spores have been seen to pass out into a superficial drop. The sporangial drops are less conspicuous, as surviving pieces of wall may render them relatively opaque. Probably most of the Mucors with thick ('fragmenting') walls are of this type, which remains chiefly water-dispersed.

Absidia glauca is a *spore-mass-shedder* with relatively little hyphal dispersal. Despite such adaptations to air dispersal as stoloniferous growth, rigid sporangiophores, and a columella which collapses into a cup, liberating the whole spore mass, it forms sporangial drops, scatters no single spores in air, and seems to be readily water-dispersed. It is thus intermediate in type.

Rhizopus nigricans, however, exhibits advanced adaptation to air dispersal. The sporangiophores, borne aloft on 'stolons' and firmly 'rooted' on their substrate, remain rigid when dry, and the collapse of the columella into a bell-shaped cap exposes the spores to air movements for long periods. Such sporangiophores, grown in a glass cell in 1939, are still erect and capable of shedding viable spores after three years. The rough angular spores are not easily wetted, and do not 'clump' closely in water, so that they dry out rapidly, and are not stuck together in mucilage. This type, however, sheds no spores when moist, but broadcasts spore masses of varying size, and single spores, when quite dry. It is therefore called a *dried-spore-shedder*.

Finally, in conidial types such as Cunninghamella we have *spore shedders* which scatter spore masses from the fresh, moist colony, and vast numbers of single spores from the dry, and are comparable in efficiency of air dispersal with many Hyphomycetes.

The Mucorales are thus brought into closer relationship with the other groups from which they have been somewhat isolated. Once it is realized that the Mucor sporangium is a water-dispersal mechanism, it can bear some comparison with that of the soil Oomycetes, especially in those species which liberate akinetes, and at the same time the various conidial forms, some of them approaching those of the Plectomycetes, become intelligible as adaptations to air dispersal.

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[1] NATURE, **143**, 286 (1939).

SEA WAVES: THEIR GROWTH AND SUBSIDENCE

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THE effect of tidal streams on swell was discussed in NATURE of February 21, p. 219, the standard for comparison being the slack-water state. Estimates depended on the fact that, in swell, waves retain their identities as individuals. But wind-forced waves cannot do so, even when there is no change in stream, because, with speed proportional to root of length, their periods lengthen as they grow—see below—and in so far as this affects the issue the arguments for swell may not hold good. But stream, tidal or otherwise, can also influence rate of growth, for which no slack-water standard is available, the laws of growth being still unknown. It is therefore necessary to improvise.

It seems that any system of wind-forced waves consists of at least three series: the primary and most conspicuous waves, the smaller secondary ones which ride upon them, and the long low waves[1,2], more akin to swell, that are masked by the primaries. It may be assumed that, under stabilized conditions, steady wind of given strength gives rise to primary waves of given average length and height, according to fetch and to strength and direction, or absence, of stream. But the only data available are two independent sets of observations, which, when combined, give figures for primary waves due to the strongest winds ordinarily met with. These figures are merely tentative, but suffice to show the general trend, and to illustrate the principles involved.

First, there are Stevenson's equations[3], intended to give greatest wave height according to fetch:

$H_{max.} = 1{\cdot}5F^{\frac{1}{2}} + 2{\cdot}5 - F^{\frac{1}{4}}$ for fetches from 1 to 39 miles,

$H_{max.} = 1{\cdot}5F^{\frac{1}{2}}$ for fetches from 40 to 120 miles, F being fetch in miles. Secondly, taking Wilton's[4] theoretical limit of 0·13 for steepness as applicable to new-born waves, the more reliable recorded measurements, including many of those summarized by Gaillard[5], indicate that for wave-lengths up to 400 ft. the greatest steepness ordinarily met with in the open may be expressed as:

$$S_{max.} = (7{\cdot}5 + 0{\cdot}3H)^{-1},$$

$$\text{that is, } L = 7{\cdot}5H_{max.} + 0{\cdot}3(H_{max.})^2.$$

There is no guarantee that all the measurements on which these equations are based relate to slack water, as will be assumed here. And the equations will be taken as the history of growth of a definite wave system under steady wind, although the strongest winds over short fetches are unlikely to persist over long ones. The following equations result:

$$\frac{dP}{dF} = 9H(2{\cdot}5L^{\frac{1}{2}} + 0{\cdot}15L^{-\frac{1}{2}}H^2)\,(0{\cdot}75F^{-\frac{1}{2}} - 0{\cdot}25F^{-\frac{3}{4}}) \text{ up to 39 miles,}$$

$$\frac{dP}{dF} = 25L^{\frac{1}{2}} + 1{\cdot}5L^{-\frac{1}{2}}H^2 \text{ from 40 to 120 miles,}$$

P $(=EG)$ being power, that is, energy per sq. ft. of water surface multiplied by its speed to leeward. The resulting values are as in the table below.

F	H	L	$S = \frac{H}{L}$	$\frac{dP}{dF}$	Hours before stability of regime	$\frac{d\,(EL)}{dF}$	Waves lost, % per mile of fetch
1	3·0	25	0·120	173	½	935	8·7
4	4·1	35	0·114	162	1½	1,040	4·0
7	4·8	43	0·112	165	2	1,200	2·8
10	5·5	50	0·110	175	3	1,350	2·1
15	6·3	59	0·107	183	4	1,550	1·5
20	7·1	69	0·103	197	5	1,800	1·2
30	8·4	83	0·101	211	6½	2,150	0·9
40	9·5	98	0·097	(244)	8	(2,700)	0·8
50	10·6	113	0·094	282	9½	3,350	0·65
100	15·0	180	0·083	360	16	5,450	0·35
(200)	21	290	0·07		(25½)		(0·2)
(300)	26	400	0·065		(34)		(0·13)
(400)	30	500	0·06		(41)		(0·1)

The figures for dP/dF only relate to power effectively used in raising the primary waves. More is required for the other series, viscosity, turbulence, breaking, and to give leeway to the water near the surface. Nevertheless, they indicate that the wind acts more efficiently as the waves lengthen, and so, except at quite an early stage, by pressure rather than by friction, the area of application of the pressure speeding up as the waves move faster. Later, well beyond the limit of Stevenson's equations, diminution in steepness and in relative speed of wind and waves will cause the pressure to get less, and dP/dF to do the same.

The figures for time show how long the wind has to blow before the sea attains a steady maximum for a given fetch. They are based on the speed of the energy of the primaries.

EL, the total energy of a wave, per foot of crest, tends to concentrate near the crest just before breaking, and should therefore be an index of striking force against a breakwater. Values are given for $d(EL)/dF$ to show how, with steady wind, an extra mile added to a long fetch increases maximum striking force much more than when added to a short one. They are based on the derived expressions,

$(60H^2 + 4{\cdot}8H^3 + 16LH)\,(0{\cdot}75F^{-\frac{1}{2}} - 0{\cdot}25F^{-\frac{3}{4}})$ for short fetches,

$(60H^2 + 4{\cdot}8H^3 + 16LH) \times 1{\cdot}125H^{-1}$ for longer fetches.

Owing to lengthening of period, when waves increase in length from L_1 to L_2, one wave in every $\sqrt{L_2} \div (\sqrt{L_2} - \sqrt{L_1})$ has to disappear. In other words, one wave in every $2L.\frac{dF}{dL} + 1$ vanishes in each mile of fetch. The figures given for percentage loss show that the waves become more permanent with greater fetch, and presumably they then behave more like swell with change of stream. However, it is with these longer waves that stream has least effect on swell.

But stream may have consequences which do not arise with swell, for not only may it affect rate of growth, but also it may alter effective fetch. For example, when there is a local wind in the open, and so not blowing off a weather shore, speed over the ground becomes irrelevant, and yet stream may modify the fetch. Travel of the centre of a cyclonic disturbance is an analogous case. It increases fetch in one semicircle, by mere coincidence the one called 'dangerous' for quite a different reason, and reduces it in the other[6]. The speed of the centre in relation to that of the wave energy is the relevant factor.

Consideration of the effect of stream on rate of growth raises the rather puzzling problem of the hairpin bend. A river takes a hairpin bend, and the wind blows up one reach. Alternatively, it may be blowing up an arm of the sea with a narrow entrance, up the Solent from Hurst would be a case in point. Given, say, a 3-knot weather-going stream, the waves will fail to stem the tide until they attain a 5-ft. length, and their energy will fail to do so until they become 20 ft. long. Presumably waves do form near the weather shore when it starts to blow, but it looks as if they must be soon dispersed by breaking. The solution may be that those which form to leeward, and so in their early life are independent of speed over the ground, attain the lengths necessary for survival before they are swept back to the weather shore. In that case there should be waves of appreciable length where there is almost inappreciable fetch, after the wind has been blowing long enough for the conditions to be stabilized. It would be interesting to know what actually does happen.

But assuming that a stable regime has been attained, it is possible to roughly estimate the change in the demand for wind energy, and so the surplus available for increasing the sea, that a weather-going stream entails. Wave power over the ground is $E(G + C)$, C being stream in ft./sec., and negative for weather going. Let E_1G_1 apply to a given position, and E_2G_2 to another position a mile to leeward. The increase in wave power within that distance, that is, over a strip of water a mile long and a foot wide, will be $E_2G_2 - E_1G_1$ in slack water, and $E_2G_2 - E_1G_1 + C(E_2 - E_1)$ with stream C. That would only be strictly correct if the wind could be so adjusted that E_2 and G_2 might retain their slack-water values. Then $C(E_2 - E_1)$ would be the change which C entails in the demand for power, but it may also be taken as a rough estimate of the surplus available for increasing the sea when the stream has made to the weather without change in wind, a surplus additional to any due to greater speed of wind over water. To put this in another way, $\frac{d(EC)}{dF} = 16HC.\frac{dH}{dF} = 18C$ ft.-lb. per sq. ft. per sec. per mile, for Stevenson's highest waves with long fetches. The corresponding expression for short fetches would be $(18 + 34F^{-\frac{1}{2}} - 18F^{-\frac{1}{4}} - 10F^{-\frac{3}{4}})C$, giving $24C$, $19C$, $17{\cdot}5C$, $16{\cdot}8C$, $16{\cdot}3C$, $16C$, $15{\cdot}8C$ for the fetches in the table.

To take an example, the value of $18C$ for a 3-knot stream is 90, a constant surplus for weather going, and deficiency for lee going, stream comprised in the increasing slack water figures for dP/dF for the longer fetches in the table. Thus, as with swell, stream seems to have less proportionate effect on longer waves; and from the way in which the sea steepens when the stream turns to the weather, it looks as if the surplus is used in heightening rather than in lengthening them, and so in intensifying rather than in speeding up their energy. But this line of reasoning for the case in which a weather shore has to be taken into account has obvious defects, and it is only put forward in the hope that someone may be able to explain what really happens.

Now as to subsidence. The rate at which swell subsides owing to the viscosity of the water can scarcely be measured, but it has been calculated by Stokes[7], who, taking as examples waves 2 in. and 240 ft. long, has shown that it is much slower for the longer waves. Unfortunately, his formula gives the daily loss in height for the 240-ft. waves as only ½ per cent, and this seems much too small. In fact, a steepish swell only 100 ft. long should subside into an almost flat calm after a couple of days, whereas by formula it would only lose a tenth of its height a week. The probability is that other effects preponderate. Thus a short sea is generally local, and always so in narrow waters. Therefore the tail of its energy will soon pass on, and leave a calm behind. Again, waves lose height because their energy only travels half as fast as they do, and the shorter waves will lose height more quickly on this account. Compare two hypothetical swells, with 6,000 waves, 400 ft. and 100 ft. in length. They will cover 400 and 100 miles to start with. The middle waves of each will start to lose height, for the reason mentioned, when they have travelled through these distances, that is, after 15 and 7½ hours, as the case may be.

The modulus of viscosity is based on frictional action between layers shearing one over the other. On the other hand, water movement under wave action involves two-dimensional distortion, what were elementary cubes in calm being distorted, approximately, from upright to horizontal oblongs, cubical form being passed midway. If the work done against viscosity were proportional to the linear distortion of the cubes, the loss in wave height per second would be absolute, and not a percentage one, and proportional to $L^{-\frac{1}{2}}$, while the distance through which the waves would have to travel before they completely flatten down would be proportional to LH. That seems more in accordance with ordinary experience.

Perhaps an actual example will be more convincing. The period of the surf on the Guinea Coast, 10–12 sec., is about double the ordinary period of waves in the Straits of Dover. The surf probably originates in energy that has travelled from the Southern Ocean, a journey of at least a week, while hours rather than days would be the measure of the time of calming in the Straits.

But to return to the original question of length and height in relation to wind and fetch. Determination of the empirical laws should go some way towards solving the problems that surround wind-forced waves. Measurements taken at lee shores with various but preferably small exposures, during steady winds of various strengths, might give some clues, and they could easily be made where the conditions are suitable. In any event, waves affect so many things, ships—breakwaters, erosion and littoral drift—that further knowledge as to their behaviour can scarcely fail to pay.

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[1] Vaughan Cornish, "Waves of the Sea", 87.

[2] Jeffreys, H., *Proc. Roy. Soc.*, A, **107**, 189.

[3] Stevenson, Thomas, "The Design and Construction of Harbours" 2nd ed., 22–26.

[4] *Phil. Mag.*, (6) **23**, 1055 (1913).

[5] Gaillard, "Wave Action", 32, 76.

[6] See also Vaughan Cornish, "Waves of the Sea", 121.

[7] Stokes, "Math. and Phys. Papers", 3, 42 (with footnote).

NEW SEISMOGRAPH STATION AT LOGAN, UTAH

THE installation of a seismograph at Utah State Agricultural College was made possible through a gift from the estate of the late Thomas E. Oldham, an English-born resident of Logan, who died in 1938 ("The Oldham Seismograph station at Utah State Agricultural College, Logan, Utah", by J. Stewart Williams, *Bull. Seis. Soc. Amer.*, 32, No. 1, January, 1942). The name is a very happy one in view of the history of seismology, though the late Thomas E. Oldham of Utah bears no known relationship to Thomas Oldham of the Geological Survey of India (1816–1878), and R. D. Oldham his son (1858–1936), who first recognized the longitudinal and transverse character of the two types of preliminary waves of an earthquake.

The seismograph room is in the basement of the main college building, the approximate geographical location being latitude 41° 45′ N., longitude 111° 47′ W. The station is equipped with two horizontal-component Wood-Anderson seismographs bought with the gift, and an accelerograph installed by the United States Coast and Geodetic Survey. The seismometers are mounted on concrete blocks 28 cm. high, keyed into the surface of a pier, resting in well-cemented gravels of the Bonneville delta, and standing at a height of 4,772·3 ft. above sea-level. Installation of the accelerograph was completed in July 1939 and the Wood-Anderson instruments began operation on January 26, 1940. Since October 1, 1940, all seismograms have been checked by the United States Coast and Geodetic Survey, and the results will be published in the monthly seismographic report.

The north-south seismometer has a static magnification of 716·8, the east-west seismometer one of 697·9. The period for both is maintained at 6·0 seconds, the damping ratio at 20 : 1. The recording drum has so far been run at 15 mm./m. The seismometers are in protective coverings which are also provided with water cans in an attempt to eliminate temperature variations near the instruments. The accelerograph, lent and maintained by the United States Coast and Geodetic Survey, is a No. *M*-45, with a 12-in. recorder, and has three components.

The site appears to be a particularly happy one, especially for the accelerographs, since Utah appears to be the most seismically active of the Rocky Mountain States. This latter may be related to the zone of faulting that marks the eastern margin of the Great Basin. One centre of activity has been in Washington and Iron Counties, adjacent to the Hurricane fault, and another centre lies in Sevier County between the Tushar and Sevier faults. Nearly one third of the earthquakes of Utah have occurred close to the Wasatch fault.

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Wednesday, May 27

Physical Society (Colour Group) (at the Royal Photographic Society, 16 Princes Gate, London, S.W.7), at 2.30 p.m.—Discussion on "The Relative Merits of Spectrophotometry and Colorimetry" (to be opened by Miss Dorothy L. Tilleard).

Institute of Chemistry (London and South Eastern Counties Section) (at 30 Russell Square, London, W.C.1), at 6 p.m.—Dr. H. Baines: "Recent Advances in Photographic Theory".

Thursday, May 28

British Psychological Society (Industrial Section) (at the National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2), at 1.20 p.m.—Miss May Smith: "Fatigue, a Revision of Past and Survey of Present Problems".

Friday, May 29

Royal Institution of Great Britain (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Mr. Seton Gordon: "Wild Life in the Western Highlands".*

British Institution of Radio Engineers (London Section) (at the Federation of British Industries, 21 Tothill Street, London, S.W.1), at 7 p.m.—Mr. O. S. Puckle: "Time Bases".*

Institute of Physics (Manchester and District Branch) (in the Physics Department, University of Manchester), at 7 p.m.—Dr. J. McG. Bruckshaw: "Physics in the Search for Oil".*

Saturday, May 30

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "Problems of Collective Feeding in War-time".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Metallurgist for research work in connexion with problems attending colliery wire ropes and other coal-mining appliances—The Chief Executive Officer, Safety in Mines Research Laboratories, Portobello Street, Sheffield 1 (May 29).

Speech Therapist (woman)—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (May 30).

Teacher of Mathematics and a Teacher of Physics—The Principal, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (May 30).

Lecturer in Science—The Principal, Domestic Science Training College, Knighton Fields, Leicester (May 31).

Electrical Engineer and Manager—The Town Clerk, Town Hall, St. Helens, Lancs. (endorsed 'Appointment of Electrical Engineer and Manager') (June 1.)

Senior Lecturer (man or woman) in the Science Department of the City of Leeds Training College, with special qualifications in Biology—The Director of Education, Education Offices, Leeds 1 (June 1).

Chief Laboratory Steward—The Principal, Technical College, Doncaster.

Senior Woman Lecturer in Biology—The Principal, Southlands Training College (London), at Highbury, Atlantic Road, Weston-super-Mare.

Mistress to take charge of the General Science Work—The Headmistress, Day Technical School for Girls, Fort Pitt, Chatham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

South-West Essex Technical College and School of Art. Annua Report, Session 1940–41. Pp. 23+4 plates. (London: South-West Essex Technical College and School of Art, Walthamstow.) [45

Proceedings of the Royal Irish Academy. Vol. 47, Section A, No. 6: Inherent Relations between Random Variables. By Dr. R. C. Geary. Pp. 63–76. 1*s*. Vol. 47, Section B, No. 13: R. Liffey Survey, 4: The Fauna of the Submerged "Mosses" in an Acid and an Alkaline Water. By Winifred E. Frost. Pp. 293–369+plate 6. 5*s*. Vol. 47, Section B, No. 14: The Exploration of some Caves near Castletownroche, Co. Cork (Studies in Irish Quaternary Deposits, No. 4). By A. M. Gwynn, G. F. Mitchell and A. W. Stelfox. Pp. 371–390+plate 7. 1*s*. 6*d*. Vol. 48, Section B, No. 1: The Distribution of Phytoplankton in some North-West Irish Loughs. By W. H. Pearsall and Edna M. Lind. Pp. 24. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [45

Other Countries

Smithsonian Institution: United States National Museum. Bulleti 161: The Foraminifera of the Tropical Pacific Collections of th *Albatross*, 1899–1900. Part 3: Heterohelicidae and Buliminidae. By Joseph Augustine Cushman. Pp. v+67+15 plates. (Washington D.C.: Government Printing Office.) 20 cents. [27

Ministry of Finance: Survey of Egypt. Survey Paper No. 45 Map Projections in Practice. By J. H. Cole. Pp. iii+43. (Giza Survey of Egypt.) [30

U.S. Department of Agriculture. Circular No. 632: Rice-Fiel Insects. By W. A. Douglas and J. W. Ingram. Pp. 32. (Washington D.C.: Government Printing Office.) 10 cents. [1

Indian Central Cotton Committee: Technological Laboratory Technological Bulletin, Series A, No. 53: Technological Reports o Trade Varieties of Indian Cottons, 1941. By Dr. Nazir Ahmad. Pp vii+103. 1.8 rupees. Technological Bulletin, Series A, No. 54 Technological Reports on Standard Indian Cottons, 1941. By D Nazir Ahmad. Pp. ii+115. 1.8 rupees. (Bombay: Indian Centr Cotton Committee.) [11

Bureau of Education, India. Education in India in 1937–38. P vii+109. 2.8 rupees; 4*s*. Education in India in 1938–39. Pp. vii 138. 3 rupees; 5*s*. (Delhi: Manager of Publications.) [11

Indian Forest Records (New Series). Botany, Vol. 3, No. 2: Som Additions to the "Botany of Bihar and Orissa". By H. F. Mooney Pp. v+63–120. 2 rupees; 3*s*. Botany, Vol. 3, No. 3: Five Ne Indian and Burmese Flowering Plants—*Ceropegia borii* M. B. Raizad *Bauhinia lyrata* M. B. Raizada, *Neptunia robertsonii* M. B. Raizad *Capparis chamoensis* M. B. Raizada, and *Phlogacanthus pochinii* M. Raizada. By M. B. Raizada. Pp. iii+121–128+5 plates. 14 annas 1*s*. 3*d*. Botany, Vol. 3, No. 6: The Relict Vegetation of the Shillor Plateau, Assam. By Dr. N. L. Bor. Pp. v+152–195. 2.2 rupees 3*s*. 6*d*. Silviculture, Vol. 4, No. 4: Investigations into Artifici Regeneration Details of the Dry Fuel Forests of Madras. By A. Griffith. Pp. iv+161–224+4 plates. 2.8 rupees; 4*s*. (Delhi: Manag of Publications.) [11

Forest Research Institute, Dehra Dun. Leaflet No. 6: Note o some Experiments on Cork Substitutes. By Dr. D. Narayanamur Pp. ii+4+1 plate. Leaflet No. 7: A New Type of Veneer Dryir Rack. By M. A. Rehman and Sultan Mohammad. Pp. ii+4+ plates. (Dehra Dun: Forest Research Institute.) [1

Herbertia. Vol. 8: Daylily edition. Edited by Hamilton P. Trau Pp. 186 (27 plates). (Orlando, Fla.: American Amaryllis Society 3.25 dollars. [1

University College of Science
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NATURE

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92, Upper Circular Rd, PHYSICS

REPLANNING GREAT BRITAIN

THE satisfaction which was given by Lord Reith in his statement in the House of Lords on February 11, announcing the establishment of the Ministry of Works and Planning, to be endowed with the necessary powers derived in part from the existing Town and Country Planning Acts and in part from forthcoming legislation, including that designed to give effect to the recommendations of the Uthwatt Committee, passed into concern in view of succeeding ministerial changes and the absence of the promised statement from the Government. That concern has been largely dispelled by the statement made by Lord Portal in the House of Lords on April 21. Following on Mr. Bevin's address to the opening session of the Emergency Committee of the International Labour Organisation, and succeeded by Mr. Oliver Lyttelton's broadcast on April 26, it afforded reassuring evidence not only that the policy outlined by Lord Reith is unchanged, but also that the Government is facing the problems of the post-war world, and that some at least of its members fully realize the contribution a reconstruction policy can make to the winning of the War.

Lord Portal said that Lord Reith's statement made in February still stands. The Bill already introduced in the Commons, the second reading of which was moved by Mr. H. Strauss on April 29, was the first step in the creation of a Ministry, the objective of which would be to secure the right use of land for all purposes. It would be the duty of the Minister to see that policies in regard to agriculture, transport, etc., are properly co-ordinated. Legislation has been drafted after consultation with Mr. Justice Uthwatt and Lord Justice Scott, whose reports should be available in the near future.

Lord Portal said that he fully agreed with what was said in a previous debate about the excessive number of planning authorities. Considerable reduction has been effected by the voluntary combination of local authorities, and it is the policy of the Government not only to reduce the number by planning over wide areas but also to accelerate the process. Area officers have already been selected to assist by collaboration with the local authorities, whom they will also aid in their planning work, keeping the local authorities informed of the national considerations which must be taken into account, and the Ministry of what is taking place in each area.

Referring to the need for speeding up the working of the Town and Country Planning Act, Lord Portal said that no planning would be complete which does not provide for the preservation of extensive areas of great natural beauty, and especially the coast-line. Protection of national parks and coasts from ill-considered building must be fully examined. He said he is working in the closest collaboration with the Paymaster-General on this and other questions ; and with regard to the personnel of planning, directly the War is over, it will be essential to have the building industry organized to cope with the vast amount of work with which it will have to deal. A well-balanced programme for new houses, schools and other buildings and repairs, and for having the men available quickly to do the work, is already well advanced. Demobilization both from the Services and the munition factories has already received attention, and a long-term programme of training on demobilization is an essential factor which requires to be thought out.

Lord Portal indicated that he appreciates the importance of the location of industry and of co-ordinating the contributions to post-war reconstruction from different Government departments. The services of the advisory panel of experts set up by Lord Reith will still be available, and a Bill will be introduced to take over the powers of the 1932 Planning Act.

This Bill, which received its second reading on April 29, is admittedly only a very small step, and little enthusiasm could be discerned for it in the House of Commons debate. It provides for the transfer to the Minister of Works and Planning of all the existing functions of the Commissioners of Works and the Commissioners of Public Works in Ireland and of the Town and Country Planning functions of the Ministry of Health. The exact extent of the transfer of powers, like the precise relations between the Minister of Works and Planning and the Post-master-General, is not quite clear.

The meagre advance represented by the new Bill is apparent from the valuable report issued by the Reconstruction Committee of the Royal Institute of British Architects on "Legislation affecting Town and Country Planning"*. The debate on the Minister of Works and Planning Bill is in fact calculated to arouse rather than dispel misgivings as to the Government's intention, if only from the indications it affords that the delays in the appearance of the reports of the Uthwatt and Scott Committees are due not so much to the Committees as to the diversion of their members to other duties by the Government itself. Yet until these reports have appeared, the essential legislation is deferred, and opportunities are in fact being lost and obstacles being allowed to accumulate through dilatoriness and inaction.

The Reconstruction Committee of the Royal Institute of British Architects, after a survey in some detail of present legislation affecting town and country planning, such as the Town and Country Planning Act 1932, the Local Government Act 1933, the Restriction of Ribbon Development Act 1935, the Trunk Roads Act 1936, and Acts affecting private street works and general building control, recommends first the establishment forthwith of one national planning authority with a Minister to lay down the main lines of the national plan, including trunk roads and other means of transport, assisted by expert planners, research and advisory committees as required. The establishment of regional officers of the Ministry to prepare and extend the national plan to meet the needs of the region and a grouping of the local authorities in each region for planning purposes in sub-regions or groups as required for efficient planning are next recommended. In regard to control, the report recommends that planning control should include all land, including the preservation of land essential for agriculture and public reservations for any purpose, with no exemptions for Government lands, railways or other public utilities or for agricultural buildings.

As recommended by the Uthwatt Committee, the existing control of all development by licence should be extended for a fixed period until the constructive proposals of the national plan are worked out. Such control by licence should include control over the extension of existing industry as well as the location of new industry, and a limit of not more than twenty years should be fixed for the continuation of non-conforming uses. Detailed improvements should be effected in town-planning legislation on lines which have already been recommended, subject to the adjustments necessary to fit in with the national and regional administration and to the employment of a competent architect.

On the financial side, the report recommends simplification of the acquisition of land for public purposes, with the price of acquisition stabilized at a figure not exceeding the value at March 1939, and a similar stabilization of the price of land acquisition between private persons. In each district there should be a local improvement and open spaces fund, provided partly by Government grant, partly by a limited local rate and partly by contributions payable by all developers, thus providing for essential widenings, open-space reservations and proper maintenance. Besides this, the necessary finance should be available on a national basis for the preparation and implementing of the national plan. This must cover the encouragement of agriculture and proper marketing facilities and the provision of rural water supply and electricity; the encouragement of the proper location of industry and the provision of new industrial centres, the building of suitable new towns and trading estates, including the utilization of mineral and natural resources, and the extension of public utility services; the improvement of transport, including road, rail, water and air transport; and the reservation of national and regional spaces for recreation, including national parks and coastal reserves, regional open spaces and playing fields, and the preservation of buildings of national or historic importance.

The arguments and recommendations of this report are well underlined by Mr. Roland Pumphrey in his pamphlet in the Rebuilding Britain Series*. Dealing with the relation of industry to reconstruction and particularly with the tendencies to migration to be found in industry, he gives an admirable indication of the way in which those tendencies can best be turned to account. He focuses attention on the problems which require attention, the questions, such as the probability of the drift of industries and services into the south-east of Great Britain and to the Midlands being resumed after the War, the influence of evacuation on the growth of a more decentralized metropolitan type, and the means of securing a better distribution of town and country life without injury to agriculture and amenities, to which answers must be sought before policy is crystallized.

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* Legislation affecting Town and Country Planning. (London: Royal Institute of British Architects.)

* Industry and Town Planning. By Roland Pumphrey. Pp. 36. Rebuilding Britain Series, No. 6. (London: Faber and Faber, Ltd.) 1s. net.

Mr. Pumphrey stresses the importance of preparing now, by wise legislation, by judicious placing of war-factories, war-houses and hutments, by research and by a constant watchfulness over changing conditions, and by uplifting public opinion, for the tasks which lie ahead; there must be a dynamic outlook. Everything must be related to the ever-changing panorama of human and material events. Secondly, he makes the point that British democracy should not attempt to embrace and control the destinies of the people by a comprehensive planning of all social and economic life. Rather should it, by wise governance and by devolving the necessary legislation and control, ensure the ways and means to a free co-operation for the development of the whole nation, in which industry and agriculture, town and countryside, shall find a harmony and identity of interests.

The core of the pamphlet, in fact, lies in Mr. Pumphrey's conclusion that industrial and town and country planning interests should join forces in providing an outline, based not only on the common requirements of industries, towns, transport and communications, but also with equal regard to the richest agricultural lands and scenic amenities. The details of location and environment can be left to sub-regional planning councils, but the striking of a balance between the requirements of the various parts of the country requires the advice and guidance of a central planning authority, exercising powers within a general outline of territorial lay-out and location as affecting the nation at large. Aided by an industrial advisory commission, a national planning Ministry might seek further to prepare public opinion for coming tasks by setting up well-equipped regional information bureaux in all principal centres, providing a tangible link between the Ministry and industry and the community.

In the debate in the House of Commons on the Planning Bill, both Mr. Strauss and Sir William Jowitt showed in their speeches that the Government's objective is to secure the right use of the land of Britain for all purposes; thus the various aspects outlined by the Reconstruction Committee of the Royal Institute of British Architects and in Mr. Roland Pumphrey's pamphlet are evidently under review. What is principally at issue at the moment is the excessive slowness of advance. While no exception can fairly be taken to Sir William Jowitt's contention that we should await the reports of the Scott and Uthwatt Committees before attempting legislation, Mr. Greenwood's suggestion that all members of these committees are being overloaded with other work of less importance is not reassuring. At the least it indicates that the Government does not view the matter with the same sense of urgency and importance that it is viewed by the country at large.

There can be no question that already a vast amount of the necessary knowledge has already been acquired, and that what is now essential is action, particularly legislative action, so that the fuller plans can be worked out in readiness, and power exercised where necessary to prevent further obstacles developing either during or immediately after the War. Moreover, as Mr. Strauss himself pointed out, we have to think not merely in terms of plans, but also of design and construction, of civic design and of architecture, and finally of men.

In this concluding reference to the crucial importance of the architect, Mr. Strauss touched on a point which is the main theme of a further report of the Reconstruction Committee of the Royal Institute of British Architects, dealing with reconstruction and the architectural profession, and of a pamphlet, "Plan for Living", by Mr. Clough Williams-Ellis*. The report directs attention to the lack of use of the special knowledge of the architect in Great Britain during the War. The Select Committee on National Expenditure has several times pointed to waste of time and materials directly due to neglect of such knowledge and experience in furtherance of the war effort, but the present report from the Royal Institute of British Architects is concerned more particularly with the opportunities in the period of reconstruction after the War.

The failure of town and country planning to achieve the beneficial or significant results desired is attributed partly to neglect of the services of the creative architect, and the report emphasizes the desirability of establishing so far as possible the relations between architectural and planning functions before the end of the War, as well as examining the organization and potential capacity of the profession, and establishing publicly and in good time the extent of contribution it can make to national reconstruction. In regard to the design and external appearance of buildings, the value of a consultative panel of architects to whom reference should be obligatory is discussed in some detail. The importance of the status of the official architect is rightly stressed, whether in regard to Government departments or to local authorities, and in a section on the building industry after the War the functions of the architect and the importance of training are discussed with admirable lucidity and restraint.

Mr. Williams-Ellis contrives to discuss the position of the architect in post-war planning with equal felicity and detachment. His claim for the architect as the key man in the team is advanced with reason and an approach to objectivity. That it is the architect's job and not the engineer's, in the first instance, to replace our towns, is no unreasonable contention. The outlook of the modern architect is intrinsically the more likely to bring that touch of vision and creative insight essential to give us towns and countryside which hold the possibility of a full and happy life for all, and not merely a sanitary existence. It is the architect who has the vision and whose training in civic design includes the sociological, transport, engineering and legal questions that are subsidiary but essential elements in designing the successful and beautiful town.

The possibilities of securing the basic things required for a merely tolerable existence by reasonable forethought and planning to exclude inconvenience, ugliness, dirt, overcrowding, traffic delays, lack of sunlight or open-air amenities are ably discussed by Mr. Williams-Ellis. He reminds us of the opportunities which the bold and progressive ideas of to-day offer to constructive statesmanship, and of our comparative freedom from economic limitations if only we refuse to attempt to carry on with the old wasteful and inefficient muddle of unplanned living. If indeed we fail to seize the opportunities now before us, many of them presented by the removal of obstructions by bombing, and fail to develop a nobler community marked by the sanity, order and beauty which, as Mumford has reminded us, is the final test of an economic system, democracy will indeed have shown itself unable to learn from its present enemies.

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* Plan for Living: the Architect's Part. By Clough Williams-Ellis. Pp. 36. Rebuilding Britain Series, No. 5. (London: Faber and Faber, Ltd.) 1s. net.

Fortunately technical ability and taste in architecture and town planning stand high in Great Britain to-day, and that ability and taste will have unprecedented opportunities. Both Sir Stafford Cripps and Mr. Lyttelton in their recent broadcasts, moreover, have indicated a new attitude in the Government which reflects the popular demand for something different and better. We are already entitled to assume that private ownership and vested interests will not be allowed to hold up or hinder changes needed in the public interest. Further, agreement has been reached on some such points as the optimum size for towns according to their location, siting and character, the sense of citizenship and civic pride and the provision of public amenities and cultural activities. True economy consists in efficiency, which includes not only right planning for traffic, public services, utilities, industries, commerce, health and education, but also for those no less vital needs known as amenities.

There is one point on which Mr. Williams-Ellis rightly insists. The success or failure of planning and reconstruction will finally depend on the character and ability of the men who do the job. Whether they are professional men such as architects or engineers, or administrative officials, or councillors, local or national Government servants, they must hold their posts in respect of ability, zeal and probity, and no other consideration whatsoever. On that condition the job is already half done. Without it, inefficiency, indifference and corruption will yet sabotage and bring to naught any programme or plan however brilliantly conceived.

The right note of moral conviction has been struck by Mr. Bevin, by Sir Stafford Cripps and by Mr. Lyttelton in their recent speeches. They go some way to remove the uneasiness suggested by Lord Portal's and by Mr. Strauss's speeches that progress has of late been retarded rather than accelerated. The urgent need remains for the Government to give the most explicit assurance of its earnestness and of its determination to produce the measures and policies in readiness for the testing time of armistice and the advance to a new peace economy. Nothing short of a Government declaration of its clear intention to retain control of industrial organization for so long as is necessary to bridge the hazardous period of transition, and simultaneously to secure the full adaptation of the production machine to the needs of reconstruction at home and overseas and the full employment of the working population for this purpose, will suffice to secure the maintenance of the national unity which is our safeguard from disaster. If the speeches to which we refer should check any undue pessimism, they should also stimulate unceasing pressure on the Government until there is forthcoming unmistakable evidence of the driving force and conviction of urgency which will ensure to the Minister of Works and Planning the powers and the legislation to enable him to formulate, and in due course to execute, a policy which will define and implement that outlined last February by Lord Reith and Mr. Greenwood and reiterated by Sir Kingsley Wood in his Budget speech. With nothing less will the country be content and without something more its war effort may well suffer. The Government should take the earliest opportunity of removing these doubts as to its continued determination to find "practical solutions for the immediate problems of a transition from war to peace", and to outline and amplify "a policy for the years following the War which will command the support of the nation as a whole and enable united action to proceed in peace as in war".

FALLACIES OF RACIALISM

Racialism against Civilization

By Dr. I. Zollschan. Pp. 64. (London: New Europe Publishing Co., Ltd., 1942.) 1s. 6d. net.

FOR many years Dr. Zollschan has been trying to rouse public opinion to a greater awareness of the ugly aspects of the racial theories concocted by Nazi propaganda, and its predecessors, to justify the aggressions by means of which a pathological group seeks to over-compensate for its deep sense of intellectual inferiority. The German disease is an old one, as the author shows. It was raging in Bismarck's time, and, whether voluntarily or not, Wagner increased the morbid tendency by his popularization of Teutonic heathendom in the "Ring of the Nibelungs". The Christian tradition was sick almost unto death in German universities; and theological writers, there as in Great Britain, were too often content to spin webs of sophistry to hide a void.

If we study human society objectively we cannot but realize that, whereas in the early and lowly stages of its evolution the individual is governed mainly by custom, the better equipped peoples show more tendency to value personality. Custom is apt to harden into a restrictive routine that sooner or later finds itself out of touch with ever-changing life, and the closed systems that have existed in the past have thus been led on through persecution of their best children to bankruptcy of ideas and collapse. This is the main argument for philosophic liberalism, which, in its turn, needs to guard against forgetfulness of the fact that man is a social being and has been such from the very outset of his story. To combine social order with the cherishing of personality as an agent of necessary adaptation is a chief task of mankind; and its difficulty is seen only too clearly when we realize that most 'blue prints' of a better world envisage a static condition, a sort of millennium that cannot exist. How to change without destruction of precious heritages and without degradation of personality is indeed the deepest of social problems. It is not to be solved by the selective analysis of purely intellectual effort; it must take into account the whole man and the whole social life of mankind.

Racialism supposes that mankind is divided into groups of long-distinct origin among which different heritages occur steadfastly. These heritages are supposed to be of different values in different cases; and those who claim that a certain heritage, for example, what is sometimes called the Aryan, or what is sometimes called the Nordic, is of outstanding value and endangered by intermixture, can only too easily work up an argument for domination and for elimination of others by the massacres and tortures in which the Nazis find delight.

Huxley, half a century ago, aptly said one should not speak of an 'Aryan race', any more than of a 'brachycephalic grammar'. Aryan languages spread in Europe and parts of Asia long ago; and no doubt considerable movements of population were involved, notably, it would seem, an exodus from the semi-arid grasslands of western Asia and southern Russia. But the vast majority of those who speak Aryan languages probably have only a little of the varied bodily heritages, if any at all, from those emigrants, in their make-up; and they are enormously varied in their physical, and, be it added, social and intellectual characteristics. The claim that the blond, tall longheads of northern Europe are in some special sense the descendants of these ancient emigrants is very ill-founded. The parallel claim that an ancient Nordic civilization arose autonomously and gave its achievements to Europe is too absurd to be discussed by anyone who has thought of the early history of the western Baltic with its fusion of at least two diverse immigrant cultures and, as usual, an interesting development following that interpenetration of different heritages and the accompanying liberation from the repressions of imposed routine obedience. It is exchanges that fertilize civilization.

There is little enough ground for ascribing a separate and isolated origin and development to the tall, long-headed blonds of northern Europe. Sweden still has individuals carrying characters, including a relative brunetness, that are widely thought to have been maintained from very early, probably Palæolithic times and are old-established even in Sweden. Archæology tells us of a number of immigrations, along the Arctic zone, from the south-east and from the south-west. Biology suggests that in this cool environment maturity comes relatively slowly and bony growth may be prolonged. The coincidences between the distribution of blondness and the area of marked cloudiness in this zone of low insolation are at least suggestive. It is thus highly probable that the different physical characters we possess have different histories and, however durable some bony features may be, they are not unchangeable. How much more is that the case with social and intellectual features!

Nevertheless, we must remember that there are interesting cases of inheritance of mental characteristics, of all grades, that are not to be ascribed by any means solely to environmental influences.

It may be that those who have lived for generations under a climate that almost forces people to activity to keep warm, and is nevertheless not so cold as to be severely repressive, may be energetic folk, may, in the terms of Sir Patrick Geddes, have a high ratio of katabolism to anabolism; but their energy may find outlets in constructive work just as well as in destruction. They are not committed to predatory effort by their biological constitution. Indeed, many a peaceful and constructive Dane very likely has more of this activity in him than the would-be Nordic Prussian who gratifies his *parvenu* Nordism and expends his intellectual activity on brutality to Poles, Czechs, Jews, French, Dutch, yea, even Norwegians and Danes.

Julian Huxley contributes a characteristically vigorous and thoughtful preface emphasizing man's power of conceptual thought which can build up a tradition; in other words, can add a transmissible heritage that need not be linked to a physical one. As he says, "most of the achievements on which our 'white' or 'Nordic' civilization is based we owe to the brains of brownish Asiatics—the alphabet, agriculture, building in stone, metallurgy, the wheel and so forth". He, like Dr. Zollschan, makes his point clearly that one of the novelties introduced by man into evolution was that of universal and conscious values which, once discovered, have an almost independent existence, a momentum of their own.

The preface might have added a little more spice had its author recalled the famous verse of Hilaire Belloc which describes the Nordic man: "His legs are long, his wits are slow". Whether Belloc's generalization has more scientific value than that of Houston Stuart Chamberlain and the Nazi demagogues one would not like to have to decide; but it at least has a touch of humour about it and none of Hitler's mentors—Haushofer, Streicher, Rosenberg—could ever be credited with that.

The presumptuous claim that racialism is founded on Darwin's work might be more drastically destroyed than it is in Dr. Zollschan's book. He is clear, as every thinker must be, that neither can victory in war be a criterion of survival, nor can survival as a biological fact be confounded with superiority of value. What he might have emphasized is that the idea of the Darwinian process as mere struggle is inadequate. The mammals have become a large, powerful and widespread group largely thanks to the elaboration among them of maternal devotion; and that factor has been much developed in the species of mammal to which we belong, one of the most widely distributed of all. With this development among mammals has gone an elaboration of group life, which, again, has had a unique blossoming in our own species. We are still, of course, at an early stage of our social evolution, and have a great deal to learn.

Dr. Zollschan sees what a large part religion plays in social maintenance and evolution. He sees, too, that insistence on untenable, anthropomorphic religious ideas has weakened the social influence of traditional religion among us. The Nazi racialism and other varieties of totalitarianism are in a large measure attempts to find a new religion which, as the author well says, in these days must inevitably try to achieve a link with the revelation of science. Whatever may be thought concerning other forms of totalitarianism, the Nazi variety essentially exemplifies the revolt of the sub-human and the degenerate against the advance of the social and ethical towards a more complete humanism.

The battle against Nazi decadence is the battle for peace and goodwill and their outcome in the wide humanism that science is making possible.

H. J. FLEURE.

EMBRYOLOGY OF THE RHESUS MONKEY

Embryology of the Rhesus Monkey (*Macaca mulatta*)
Collected Papers from the Contributions to Embryology, published by the Carnegie Institution of Washington. (Publication No. 538.) Pp. iii+148+52 plates. (Washington, D.C.: Carnegie Institution, 1941.) 1 dollar.

IN 1925 the Carnegie Institution of Washington undertook a programme of research into the problem of reproduction in monkeys. Its first step was to establish a colony of rhesus macaques in its Department of Embryology, which was then directed by Dr. George L. Streeter. The Department is next door to the Anatomy School of Johns Hopkins University, where a few years earlier Dr. George W. Corner had begun similar work on the same species of primate. The close affiliation of the two laboratories proved fortunate, and the success of the Institution's programme of research, now directed by Dr. Corner, is marked by a number of monographs published in its "Contributions to Embryology". Five of these monographs have now been collected in a single volume.

The volume opens with Hartman and Corner's paper on the first maturation division of the macaque ovum. Like the others of the series it is beautifully illustrated; and it demonstrates that, as in the vast majority of mammals, the first maturation division occurs within the Graafian follicle just preceding its rupture. The second paper, by Lewis and Hartman, takes the story a stage further and discusses fertilized and unfertilized ova recovered from the Fallopian tubes, and the further behaviour of which has been studied *in vitro*. The process of segmentation has been successfully filmed, but attempts to fertilize the eggs *in vitro*, unlike similar experiments with rabbit eggs, failed. The third monograph, by Heuser and Streeter, deals with the early development of the embryo. Cleavage of the fertilized ovum leads to a selective distribution of the complex material of the original one-cell egg into the daughter cells of, first, the morula, and then the blastocyst. This process represents the specialization of 'primary orders of tissue', a process which the authors point out depends on intrinsic genetic rather than environmental factors, and by which the auxiliary elements of the egg separate themselves from the true formative elements. Strictly speaking, it is a process which does not represent growth, since the mass of the cells of the free blastocyst is in fact less than that of the original egg cell. The moment this primary differentiation has occurred, its cellular products themselves begin to exert a mutual influence upon each others' further development.

The factors responsible for the transport of the blastocyst and the determination of its site of implantation, which occurs about the ninth day after ovulation, are unknown, but the process of implantation itself has been studied in the greatest detail. So, too, has the differentiation of the 'germ disc', which in its early stages is synonymous with the so-called 'embryonic ectoderm', and which the authors regard as exercising a function similar to that of the dorsal lip of the blastopore, in so far as the disc has a "dominating influence in determining the fate of the neighbouring auxiliary cells as well as those migrating out from the germ disc itself". During this early stage of development the disc is growing as a tissue culture in a fluid medium provided by the surrounding auxiliary cells. It owes its organizing propensity to the fact that its constituent cells represent an unspecialized residuum of the original germ plasm. Further segregation of cells, as development of the disc proceeds, brings these particular cells into relation with the primitive streak. It is not until the latter has given off definitive embryonic ectoderm, mesoblast and gut endoderm cells that the residuum of primordial germ plasm is finally used up. The endodermal contribution of the germ disc is not clearly distinguishable from the cellular proliferation, perhaps induced by the germ disc, of the primitive endoderm cells—which are a direct product of the primary segregation and cleavage of the egg.

Heuser and Streeter thus define a first order of segregation or specialization in embryonic development in which the formative elements of the fertilized egg become separated from the auxiliary elements; a second order of segregation in which the formative elements containing the residuum of primordial germ plasm become organized as the primitive streak, which is the locus of the "second order of specialization"; and further orders of segregation, for example, the separation of the ganglion crest from the neural ectoderm, which finally become too numerous to be kept in serial levels. The general conclusions reached are of considerable importance to comparative embryology. The authors do not subscribe to any simple and far-reaching phylogenetic theory. As they put it, "the embryo at all stages is a living organism and is to be analysed as a biologic problem rather than purely a morphologic abstraction". For example, "what were thought to be vestiges of great phylogenetic importance appear, in many instances, to be temporary embryonic structures, essential to a particular period of development."

The fourth monograph of the series is by Schultz, and discusses fœtal growth, with special reference to body proportions, certain ectodermal structures and ossification. The rhesus monkey at birth is relatively much more advanced than a new-born human infant, but fœtal growth-changes in body proportions are much the same in both species. A notable exception is the brain, which in the new-born rhesus monkey is about half the final size achieved in post-natal life, and in man a quarter. The fifth and final monograph of the volume, by Wislocki and Streeter, is a very detailed discussion of placentation. It demonstrates clearly that, in the differentiation of the trophoblast, there is a striking similarity between man, anthropoid apes and the rhesus monkey. The human placenta can be regarded as having been derived from the catarrhine variety by the acquisition of an interstitial mode of implantation. Here the authors depart from a widely accepted view, in so far as they suggest that human interstitial implantation is not due to the trophoblast becoming more "invasive", but to the endometrium becoming less resistant to invasion—as shown by the absence in man of proliferation of the uterine epithelium at the site of implantation. This paper ends with a stimulating discussion of the functional relationships between egg and endometrium.

The Carnegie Institution is both to be congratulated on the achievement which the volume represents, and to be thanked for having made these five monographs available between the same covers. It is to be hoped that this is only the first of a series of similar ventures, and that other volumes will follow in which further related studies of primate reproduction and growth will be made available, in the same convenient form, to students of the subject. S. ZUCKERMAN.

Handbook of Chemical Microscopy

By Prof. Émile Monnin Chamot and Prof. Clyde Walter Mason. Vol. 2: Chemical Methods and Inorganic Qualitative Analysis. Second edition. Pp. xi+438. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 30*s.* net.

THE rapid development in recent years of microchemical methods of analysis has called forth an excellent series of text-books on various aspects of the subject and, of these, Chamot and Mason's "Handbook of Chemical Microscopy" holds a deservedly high place. In the second edition of vol. 2 now under review, most of the subject-matter in the original work (reviewed in NATURE, 130, 619; 1932) has been retained but a number of new tests have been included, some of them employing organic reagents such as dipicrylamine, nitrobarbituric acid and diphenylcarbazide. The most extensive additions have been to the sections dealing with the detection of the alkali metals, the metals of Group IV of the periodic classification and the anions of the sulphur group where tests have now been included for the polythionates; a scheme for the identification of the various sulphur-containing anions has also been drawn up. To illustrate these new procedures there have been included forty-eight additional photomicrographs. All the photographs are excellently clear and the same care has been expended in making the descriptive matter lucid and yet concise. The text is remarkably free from errors, while there is a good index. The volume is handsomely bound, so that the authors and publishers have collaborated to produce a book which is indeed a joy to handle and to use.

Beyond the "Isms"

By Olaf Stapledon. (Searchlight Books, No. 16.) Pp. 128. (London: Martin Secker and Warburg, Ltd., 1942.) 2*s.* net.

THERE has been a remarkable spate of books inspired by the War, and they are none of them of the furious anti-Hitler type which the case would warrant. The writers are stirred by social passion among themselves. Let them use the war as binding the nation in determined and religious ardour which will stretch far beyond the war itself. Sir Richard Gregory's "Religion, Science and Civilization" is, of course, of ampler scope and full of interesting matter. It leans in the same direction as Mr. Stapledon in stressing the religious side but avoiding any orthodox religions. The most striking feature of all these religious-social war exhortations is that they come from and go to the religious who frankly discard the accepted creed of the Church of England or any other church. Their attitude is forward-looking, but not attached to any church. The future of organized religion will therefore become more and more vague and insincere, unless the discard of impossible doctrines and legends is frankly made.

This is being done in certain churches, and, of course, in multitudes of private prayers.

The crisis is a useful one. A new archbishop to set the tone.

Religion is our attitude towards the Infinite in company with and for the good of others. This must differ from worshipper to worshipper. The Infinite may find its own. F. S. MARVIN.

Supplement to the British Pharmaceutical Codex, 1934

Part 1: Monographs (New Monographs). Pp. iv+101. (London: The Pharmaceutical Press, 1942.) 5*s.* 6*d.*

THE British Pharmaceutical Codex was last published in 1934, but it has been brought up to date by the issue of three supplements in the last few months. The first supplement deals with dressings, while the second contains additions and amendments to the formulæ for galenical and other preparations in Part 3 of the Codex. It is designed to overcome difficulties arising from the War by authorizing the use of alternative formulæ for preparations in which certain of the ingredients are either in short supply or reserved for more important purposes. The third supplement, which corresponds with Part 1 of the Codex, is most likely to interest the scientific man. It contains 66 new monographs describing substances recently introduced in medicine, and substances liberated by the recent emergency legislation from the restrictions imposed by foreign patents. About half of these substances have already been described in the various addenda to the British Pharmacopœia; the remainder now receive their first official description in Great Britain. The sections on "Action and Uses" in this supplement will interest many who are not concerned with pharmaceutical details. They give a summary of some of the more important recent advances in pharmacology and therapeutics, and are more balanced and more authoritative than many of the corresponding sections in the Codex, which have retained much that is now archaic, probably because there was no definite reason for believing it to be incorrect.

Aircraft Instruments

By George Ellis Irvin. Pp. x+506. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 35*s.*

THIS book is composed mainly of detailed descriptions, with comprehensive maintenance and testing schedules, of standard American products; the thoroughness which is characteristic of American trade booklets is evident in the treatment. Other than the omission of oxygen instruments and of the absence of synchroscopes from the chapter "Tachometers and Synchronizers", the volume covers most of the American instruments in general use. It is excellently illustrated and reproduced, and in this respect is marred only by a number of proof-reading errors.

The author makes little attempt to explain the physical conceptions leading to the design of flight and navigation instruments, and it is perhaps as well that the scope of the book is restricted in this direction. For example, the statement "Air-speed indicators show the speed of the airplane relative to the air through which it is travelling" is incorrect, unfortunately for the navigator; and in the chapter on compasses, some confusion over the north end of a magnet is evident.

The useful properties of all the instruments are fully described, but their limitations, both fundamental and in practical usage, receive little critical attention. The book is useful for reference purposes, but it cannot be recommended to the serious student of aeronautics or instrument design.

THE WEED PROBLEM*

By PROF. E. J. SALISBURY, C.B.E., F.R.S.

TO define a weed is not an easy matter since this term of opprobrium is applied in different ways by different persons. Probably the best definition is that of a plant growing where we do not want it. Nevertheless to many the designation implies a certain measure of uncontrollability, and it is more particularly these weeds, which are the bane of the farmer and the gardener, that concern us here.

It has been estimated that, before the War, the cost of weeds to Great Britain was of the order of some sixteen and a half million pounds a year. It is, indeed, probable that this is a very conservative estimate, since the monetary losses due to the indirect effects of weeds, which are by no means inconsiderable, are well-nigh impossible to assess.

The most evident effect of weeds is that they compete, with our crop and garden plants, for such essenials as water, the mineral nutrients necessary for all types of vegetation in smaller or larger degree, the carbon dioxide of the air, and for the radiant energy upon which the manufacture of sugars by the green leaf depends.

The competition for the soil moisture is of a dual character. If plants are growing in a very wet soil the amount of water which the plant can take up, provided there is adequate aeration, is probably determined more by the efficiency of the internal water-conducting system than by the extent of its roots. But when the moisture in the soil is low in amount the extent of the absorbing surface of the root which is in contact with the soil is often the governing factor in the supply, and it is naturally under just these conditions that the water supply is most important. The extent of the root system is also of importance as affecting the amount of nutrients available to the plant, since upon this will depend the volume of soil exploited. This is especially true with respect to those nutrients in regard to which the soil is most deficient.

The development of the root system of a plant is now known to be greatly influenced not only by the aeration and texture of the soil but also by the presence of root systems. The mechanism of this interference is not yet fully understood. It is likely that the intake of oxygen and the release of carbon dioxide during the respiration of roots may play an appreciable part. Indeed, most roots are intolerant of high concentrations of carbon dioxide in the soil atmosphere. The presence of numerous weed roots will therefore compete for the available oxygen and render the soil atmosphere less favourable for root development and the intake of nutrients. In addition there is experimental evidence that soluble substances are produced by roots, perhaps during the breakdown of dead cells, which are of a toxic nature and vary in their deleterious character according to the species concerned.

Some astonishing figures have been obtained by the Canadian botanist Pavlychenko showing the extent of the root system of cereals when grown with and without the competition of other plants. When wheat and rye were raised as single individuals with no other vegetation in their neighbourhood and measured as if all the roots were cut off and placed end to end, as one continuous thread, the total length was more than forty-four miles for a wheat plant and more than fifty miles for one of rye. When grown in drills, as in normal cultivation, so that the crop plants in the same row compete with one another, the root-lengths diminished to from one half to two thirds of a mile, while when weeds were present in addition, between the rows of cereals, the total length was only about one ninth of a mile. The presence of charlock in a field of wheat can reduce the root system of the cereal to one fifth or even a tenth of its extent when weeds are absent.

There is reason to believe that root competition and the resulting effects upon the supply of nutrients may often be the most important of the deleterious effects brought about by weeds. Weeds thus deprive our crop and garden plants of water and nutrients in two ways. First by reducing the volume of soil occupied, and secondly by depleting those essential requirements which the diminished volume of soil contains.

Sometimes the chief nutrient thus depleted is nitrogenous material, and the harmful influence of some weeds can be greatly alleviated by applications of nitrogenous fertilizers. Even where there is no root-competition, mere crowding, as Dr. Brenchley showed with plants in separate containers in water culture, in itself increases this nitrogen requirement. But it must be emphasized that the nearer any nutrient is to the minimum requisite for crop growth, the more likely it is that the presence of weeds will bring about a real deficiency.

We know that weeds absorb the essential elements in very different amounts. Thus the common bracken contains an exceptionally high proportion of potash, so that plants in competition with bracken are liable to suffer from potash starvation, but for the same reason bracken fronds, cut early in the season, provide a most useful material for composting in these days of shortage in potash supplies.

We now know that broad beans and beets, in particular, require minute traces of boron, and possibly all plants require some. Lack of minute quantities of copper and cobalt in a soil, and hence in the herbage developing upon it, may lead to serious and even fatal diseases in sheep. The study of these micronutrients is as yet in its infancy, and one of the gaps in our knowledge that requires filling is in respect to the effect of weeds in influencing the availability of these essentials for healthy growth. We do know, however, that these micronutrients are often present in amounts only just adequate for the crop, and one or other is not infrequently deficient, at least in an available form.

Some weeds take up these rarer elements in quantities as great or even greater than do our garden and crop plants. It is therefore extremely likely that the presence of weeds competing for these micronutrients may accentuate even if they do not create deficiencies.

So far as I am aware, gold has not yet been shown to be essential for vigorous plant growth, but data obtained by the distinguished Czechoslovakian plant physiologist, Prof. B. Němec, showed that whereas a metric ton of dried maize contained only 2 gm. of gold, that objectionable weed the field horsetail (*Equisetum arvense*) contained 63 gm. and the marsh horsetail (*E. palustre*) 610 gm., although the same dry weight of the soil only contained a tenth of a gram. Let me hasten to add that the yield per acre is not sufficient to warrant the cultivation of horsetails for this purpose.

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* Substance of a lecture delivered at the Royal Institution on April 30.

There is another aspect of the weed in relation to the rarer elements that is of considerable economic importance in certain districts. Some trace elements, far from being beneficial to stock which feeds upon the herbage containing them, are extremely poisonous. A particularly striking example is afforded by the seliniferous soils of the United States. The pastures which grow on these soils may be quite innocuous, since the comparatively insoluble selenium is only absorbed in small amounts by the grasses and many species of herbs. But certain weeds which occur in these pastures, particularly species of milk vetch (Astragalus spp.) have such a capacity for absorbing and accumulating selenium that they render the herbage highly poisonous to browsing animals. The so-called 'teart' pastures of Somerset, Gloucester and Warwickshire are now known to be deleterious to cattle owing to the presence of molybdenum in the herbage, but whereas dried rye-grass growing on these soils will contain only about one part of molybdenum in a thousand, white clover will contain about nine and a half times as much. Hence on these soils the clovers, which are desirable constituents of herbage in most areas, must be classed as weeds. Applications of ammonium sulphate to such pastures reduce their toxicity partly because there is an increased proportion of grass in the herbage but also because under the more acid conditions thus induced the uptake of the molybdenum is diminished.

These few examples suffice to show that the relation of weeds to the rarer elements is an important one concerning which far more information than at present available is desirable. The amounts involved are extremely small. It has, for example, been estimated that the requisite cobalt for healthy growth of sheep in New Zealand is of the order of one part in twenty million.

Competition for light by weeds and cultivated plants is often pronounced in the seedling stages, when weeds may form a canopy of foliage that precludes all but a small fraction of the radiant energy, necessary for green leaves to manufacture the plant's food, from reaching the seedlings of our crop or garden plants. But such competition for light is by no means confined to the juvenile phases of development or to recently disturbed soil. The plantains and daisies on our lawns and golf-greens suppress the grass mainly because their close-pressed rosettes cut off the light from the turf beneath. But no better example of competition for light could perhaps be found than is exhibited by that weed of the hedgerow, the common elder (*Sambucus nigra*) because it illustrates in a striking manner those biological features which most commonly render species especially aggressive in this respect. The first of these is the remarkable capacity of this shrub to form robust shoots of great length in a single season. These may attain more than six feet and quickly outstrip the shoots of their neighbours. Secondly, the very early development of the new foliage, which expands before that of other deciduous hedgerow shrubs, confers a by no means unimportant advantage in time. Thus in the south of England the average date for the beginning of leaf expansion of the elder in a normal season is about the middle of February, whereas for our commonest hedgerow shrubs, the hawthorn, blackthorn and hazel, the average date is about the third or fourth week in March. Lastly the leaves of the elder are large and collectively constitute a canopy of foliage that is relatively impermeable to the light. The total effect of these features is that the elder can create an efficient sunshade above the surrounding hedge before the leaves of the other shrubs are even fully expanded. Added to which the seedlings of the elder are remarkably tolerant of deep shade, so that they can develop under conditions that might suppress other species, and are not infrequently to be found within the hedge itself.

In addition to the direct effects of weeds in depriving cultivated plants of light, water, and nutrients, there are other important indirect outcomes of their presence, particularly as host plants of pests which enable the parasites and predators to persist in an area from which the appropriate cultivated host is temporarily absent. Thus the flea beetle, which in the past season was such a devastating pest on turnips in some areas, finds an alternative host on the charlock. Weeds also harbour eelworms and virus diseases, while the slime fungus which causes club-root disease of our cabbages and other species of Brassica, is often to be found flourishing on Cruciferous weeds, particularly treacle-mustard (*Sisymbrium officinale*).

With respect to insect pests that attack both crop-plants and weeds, our knowledge of deterrents and attractants, though at present meagre, offers the interesting possibility of treatment that shall not merely render the cultivated plants relatively immune but may also induce such insects to afford biological control of the weeds themselves.

The solution of the weed problem can only be found by concerted action directed on one hand towards weed destruction and on the other against their reappearance. Methods of destruction, especially by chemical means, are often immediately successful and even spectacular in their achievements, but they represent an expenditure of money, material and human effort that might in many instances be avoided. Preventive measures are usually far from being spectacular and indeed are apt not to be accorded the recognition they deserve.

Cultivation of the soil by hand, while affording an effective means of control of annual species and some perennials, is dependent upon an adequate supply of inexpensive manual labour. On the farm, mechanical cultivation can achieve much to mitigate the labour difficulty, but it should be remembered that the effective application of mechanical methods to the fallow and the growing crop demands forethought in the lay-out and spacing of the plants to this end. The chief drawback to cultivation as a means of weed control is that the repeated disturbance of the soil that may be required to keep the land clean is liable to do as much harm by disturbance of the roots of the cultivated plants as it does good by the destruction of the weeds.

The high cost of labour and the risk of undue root disturbance have been responsible for the development of chemical means of control by spraying. Of these the most effective so far devised is the method of spraying with a dilute solution of sulphuric acid which was utilized with very satisfactory results in the United States and France and has been successfully developed by Mr. G. E. Blackman in Great Britain for the control of weeds in onions and other crops. By the application of a suitable amount of lime the effects of the acid on the soil are neutralized. Nitric acid has also been employed and has the merit that it increases the nitrogen content of the soil which weeds are so liable to deplete. Some measure of control has been achieved by the use of fertilizers such as ammonium sulphate and cyanamide, and if such methods could be rendered more effective they clearly offer the advantage of avoiding expenditure of chemicals that are not in themselves of value to the crop. If more effective control by means of fertilizing sprays or dusts could be attained it would probably be greatly to the advantage of agriculture and horticulture in more ways than one. Only time can reveal the long-term influence of chemical methods on soil-structure and fertility.

Even with the most effective chemical sprays destruction of weeds is rarely complete, and those that remain, because they are freed from the competition of their neighbours, may attain a large size and in considerable measure compensate in seed yield for the small number of individuals that ripen fruit. For this reason the supplementing of mechanical or chemical control methods by hand labour may well be profitable.

On unplanted soil, drastic methods such as the application of sodium chlorate are sometimes effective against deep-rooted perennials, but little is known as to the residual effects upon the soil structure and the microscopic forms of life.

Many perennial weeds, such as the creeping thistle, the bindweed and the hoary cress, can produce shoots from quite small fragments of the roots even if these be comparatively deeply placed in the soil. Repeated destruction of the overground shoots of these until the underground parts are exhausted of their reserves of food, offer the best hope of their eradication. This has proved effective with the bracken, although the cutting has to be carried out two or three times at intervals of five or six weeks over a period of from three to five years. It has been aptly said that to stop cutting bracken before eradication is complete is like leaving a smouldering fire untended.

Biological control by the encouragement of parasites, either insect or fungal, has been utilized with varying degrees of success. Insect control has proved valuable against the cactus pest of Australia (see NATURE of September 13, 1941, p. 303). The control of bracken by means of a fungus has been attempted in Great Britain. The great difficulty in the development of biological methods is to find a parasite which is strictly limited to the kind of plant we desire to control and which will not sooner or later itself become a pest on some related or even unrelated species which we cultivate.

The weed problem is apprehended as in reality a dual one: the first being the problem of eradication, and the second the problem of preventing reinfection. The former is often far more readily accomplished than the latter, which can in general only be partially achieved.

The second category, preventive measures, are not only perhaps the most important but also their application leads us to study the biology of the weed species and thus to discover their most vulnerable points of attack.

However effectively we may have destroyed existing weeds, it is clearly imperative that they should not be re-introduced by the sowing of impurities with our seeds. Modern screening methods which take advantage of many of the differences between crop seeds and those of other plants such as size, weight, and surface texture have accomplished much, and the number of weeds that we inadvertently sow to-day are few compared with half a century ago. The former prevalence of darnel grass (*Lolium temulentum*), which was evidently a pest in Shakespeare's day, of the blue pimpernel (*Anagallis coerulea*), and the pheasant's eye (*Adonis autumnalis*), which are to-day rare cornfield weeds, was due to their repeated introduction in seed imported from the south of Europe. Even now vast quantities of weed seeds are annually sown with grass and clover seed all over Great Britain.

The returns of the official seed-testing station show that perennial rye-grass seed commonly contains 2–4 per cent by weight of impurities, cocksfoot seed about 9 per cent, and meadow foxtail between 30 per cent and 40 per cent. Clover seeds, too, often contain between 4 per cent and 9 per cent. To understand what such proportions of impurities mean in terms of actual weed seeds, I have calculated that in every year, with the sowing of clover and grass, more than six billion weed seeds were probably also sown throughout Great Britain.

Even could we completely clean the soil of growing weeds and ensure that no weed seeds were afterwards sown, we should probably not be free from weeds for a number of years owing to the long period over which buried weed seeds can remain alive.

Careful experiments carried out on seeds buried in the soil and then placed under conditions favourable to germination, after the lapse of increasing periods of years, have shown that the seeds of the shepherd's purse (Capsella) and fat hen (*Chenopodium album*) can retain their viability for at least thirty-five years, and those of the crisped dock (*Rumex crispus*) for at least sixty years. Others, such as those of the blue pimpernel, retain their viability for even longer periods.

Apart from viable seeds already in the soil and possible impurities in the seeds that we sow, there is another source of infection that is by no means negligible, namely, the accidental introduction in manure, on our boots and clothes, and even on the implements of agriculture. The moist heat that is generated as manure ferments, or in the compost heap, does, it is true, destroy the viability of many of the contained seeds, but many there are which can not only pass through the alimentary canal of the cow or horse with unimpaired or even enhanced germination, but also can survive the subsequent fermentation.

It is worth while dwelling somewhat on the accidental carriage and distribution of seeds by our own activities, since all too little attention has been paid to this by no means infrequent occurrence.

Some years ago I carried out a number of experiments designed to test the extent to which seeds were carried about in the mud upon our boots. Mud brought into churches which had paved paths leading to the porches was placed on sterilized soil and moistened. The seedlings which afterwards emerged were found to be mostly grasses, but various other weeds were also present. It is reasonable to assume that these seeds might have been carried appreciable distances before the mud dried sufficiently to fall off. Even more effective carriage in mud is accomplished in the patterned tread of motor-tyres and the wheels of farm carts and lorries, as well as those of private cars, and are an effective means of dissemination over long distances. There is little doubt that the wayside pineapple weed (*Matricaria suaveolens*), which originated from Oregon, owed its rapid spread throughout Great Britain to this means of dispersal.

Our clothes, too, are a frequent means of seed carriage, and if after a country walk one turns down the 'cuffs' of one's trousers it is amazing the collection of seeds that can be obtained. I have sowed a number of such collections after walks in diverse types of habitat. In one instance there were no less than 325 seedlings produced when the trouser brushings were sown on sterilized soil. Of this total 284 were seedlings of various grasses, while the remaining 41 comprised five different kinds of weeds.

It is important to recognize that vegetative propagation by means of shoots that arise from the roots, though an unusual feature, is characteristic of several of our most pernicious weeds such as the creeping sorrel (*Rumex acetosella*), the creeping thistle (*Cirsium arvense*, the field convolvulus (*Convolvulus arvensis*), and the yellow toadflax (*Linaria repens*). The importance of such vegetative methods is that whereas the seedling can only successfully develop in a relatively open spot where the small food reserve in the seed will enable it to grow into the light, the shoot from a root or from an underground stem has the much larger reserves of the adult parent to draw upon and so is able to extend unchecked by the shade of its neighbours.

Owing to the prolific production of seeds (for example, a single fruit of groundsel has the potentiality of infesting about sixty-five acres in three years), it cannot be urged that because the number of seeds inadvertently introduced is small, it is therefore a matter of indifference. Indeed, when we weed our gardens it is well to remind ourselves that unless the ground is cleaned completely of all weeds our efforts may merely result in the survivors attaining to large dimensions, and thus in no small degree compensating by the magnitude of their yield for the dearth of individuals.

We must, moreover, recognize that our efforts to eliminate weeds will automatically tend to render our tasks more difficult unless it is complete. So, too, in the use of large-scale weed treatment in agriculture, it is important to bear in mind that a remedy that is only partial may in fact merely destroy the strains that are more easily killed and so we leave behind the more resistant types free from the competition of their less robust relatives; hence the latter state is worse than the first, for we have selected out a strain or strains that demand more drastic measures to compass their destruction.

If our attempt at suppression is at the seedling stage, we must know whether germination is commonly 'simultaneous' or normally 'intermittent' and what is the period of dormancy of buried seeds? So, too, it is essential to our success to know the potentialities for vegetative increase. Crops of weeds like those of economic species have their soil preferences and differential response to nutritional stimulus. In South Australia it was found that the application of copper salts to copper-deficient soils resulted in an increased yield of the cereal crop amounting to from three to eight times, but the effect upon the weeds was only to increase them by 50 per cent. It is, indeed, manifest that to combat effectively the avarice of weeds it is essential to have a far more intimate acquaintance with their biology, in all its aspects, than we at present possess. 'Know thy enemy' is as sound advice in horticultural and agricultural hygiene as in any other type of activity, and perchance we may find that a species that appears in the guise of an enemy may sometimes function as a friend.

X-RAY TECHNIQUE IN THE INDUSTRIAL LABORATORY*

By H. P. ROOKSBY
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THERE are two main ways in which X-rays have become of immense practical importance in the industrial field. The great penetrating power has been utilized in the technique of radiography for the examination of what may be described as the macrostructure of solid bodies and objects. In X-ray crystal analysis the diffraction of X-rays by the regular pattern of atoms in a crystal has been utilized to elaborate and supplement chemical and other physical methods of examining the nature and properties of a material.

X-Ray Tubes

The basic design of the modern X-ray tube is that of an evacuated jar or envelope containing two electrodes between which a high potential is applied. In an electron tube for radiographic work, the target or positive electrode usually consists of a hollow water-cooled block of copper into the face of which is set a small disk of tungsten. The other electrode is a hot tungsten filament surrounded by a metal cap or hood, the arrangement being to focus the electron stream from the filament on to the target face in the form of a rectangle. When viewed at an incident angle of about 20°, the rectangular source of the primary X-ray beam is foreshortened to a square. Comparatively compact X-ray tubes encased in oil and with shock-proof high-tension cabling are available for operation at 200 or even 400 kilovolts. Demands for radiation of great penetrating power have led to the building of units to operate at one million volts and more. One of the most recent which may be used at a million volts utilizes Freon under pressure as the insulating medium and a resonance transformer as high-tension generator. The length is only 7 ft., the X-ray tube and generator being enclosed in the one envelope[1].

For crystal analysis it is not necessary to operate the X-ray tube at voltages above 60–70 kilovolts. Moreover, some means has to be found for simple alteration of the nature of the source of X-rays in order that several different wave-lengths are available. The requirements are best met by the continuously evacuated demountable X-ray tube, with interchangeable targets each faced with a different metal. The rectangular focus is frequently viewed at almost glancing angle so that a source of X-rays effectively approaching a short line is obtained.

The radiation from an X-ray tube consists, in general, of two parts, the 'white' or continuous spectrum radiation and a line radiation the wavelengths of which are characteristic of the radiating element. It is the continuous radiation which is of practical value in radiography; in the continuous spectrum there is a sharp lower limit of wave-length depending only upon the applied voltage and decreasing with increase in voltage. To a great extent the penetrating power of a heterogeneous X-ray beam increases as the lower limit of wave-length becomes shorter, so that penetrating power may be largely controlled by the X-ray tube voltage. It must be chosen to suit the subject of examination if maximum clarity and contrast on the X-ray negative is to be obtained. As a general rule, the X-ray tube voltage should be adjusted to the lowest value at which reasonable penetration of the object is obtained. The distribution of wave-lengths or 'colour' of the X-ray beam may also be modified by inserting appropriate metal filters in its path. There is then a suppression of the longer wave-length components. By such means, and by the employment of lead intensifying screens consisting of very thin sheets of lead placed on either side of the X-ray film, scattering and secondary radiation from the specimen are substantially reduced[2]. At the higher voltages this results in a considerable improvement in clarity and definition of the image.

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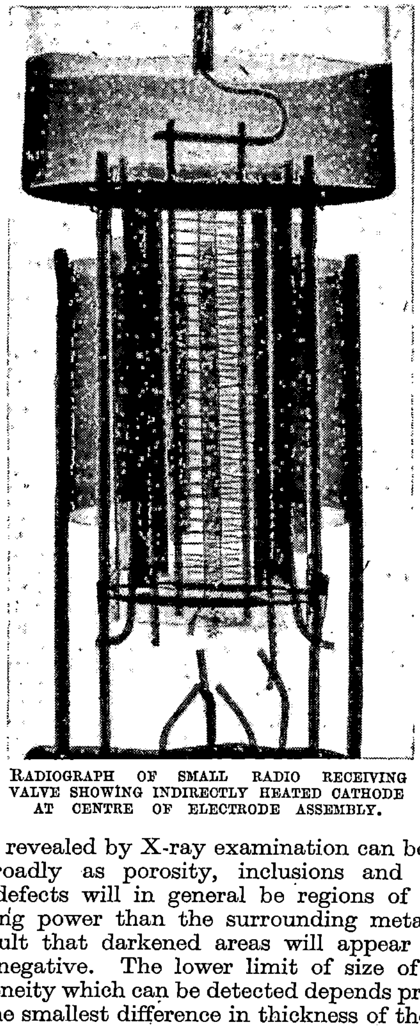
* Abridgement of three Cantor Lectures delivered before the Royal Society of Arts on March 16, 23 and 30.

Radiography

Probably the most important sphere of application of radiography in the industrial field is the examination of metal castings. The defects in castings that may be revealed by X-ray examination can be classified broadly as porosity, inclusions and cracks. These defects will in general be regions of smaller absorbing power than the surrounding metal, with the result that darkened areas will appear on the X-ray negative. The lower limit of size of an inhomogeneity which can be detected depends primarily upon the smallest difference in thickness of the metal that can be registered on the negative. For steel of the order of 2 in. thick a change of about 1 per cent may be detected. With castings of the light aluminium and magnesium alloys, which are of such immense importance in the aircraft industry, the sensitivity is generally lower, for, while it is easy to obtain adequate penetration it is more difficult to obtain good contrast.



RADIOGRAPH OF SMALL RADIO RECEIVING VALVE SHOWING INDIRECTLY HEATED CATHODE AT CENTRE OF ELECTRODE ASSEMBLY.

Radiography has not perhaps been so extensively applied to the examination of assemblies, but in many varieties of radio valve radiographic inspection has proved of great aid to development and manufacture. One of the original studies was of the large water- and air-cooled transmitting valves. Sufficient penetration of the opaque copper anode had to be obtained to delineate sharply the tungsten and molybdenum inner electrodes, and yet leave a clearly defined outline of the anode to give information as to the concentricity of the whole assembly. The technique has been extended to many special forms of small thermionic valve with opaque envelopes in which clearances between the various components are particularly critical. Distortion and deformation of the parts of the assembly during operation and during life can also be studied by taking a series of X-ray photographs at different stages, and such a series may often prove a useful guide to improvements in design because the points at which imperfections in construction occur can be so readily observed. Even when the envelope of the valve is of glass, the only practical way to examine a component at the centre of the electrode system (a tungsten heater inside a thermionic cathode for example) is by X-rays.

X-Ray Crystal Analysis

With the verification of the suggestion by Laue that the X-ray wave-lengths should be of the right order for diffraction by the interatomic distances in crystals, there commenced an extensive study of the structure of crystals. The basis of practically all X-ray diffraction measurements is the law first formulated by the Braggs, namely, $n\lambda = 2d \sin \theta$; the X-rays are regarded as being reflected from planes of atoms spaced apart by a distance d.

Of the various methods devised for the determination of crystal structures, one is of outstanding value for use in the industrial laboratory. This is that commonly known as the powdered crystal method, and consists essentially of examining photographically the diffraction effects obtained when a finely powdered crystalline substance is irradiated with a pencil of monochromatic X-rays. A single wave-length incident upon a crystalline powder gives rise to a number of cones of diffraction corresponding to the atomic planar distances of which the characteristic crystal structure is made up. The cones of diffraction may be intercepted by a photographic film in several ways. In the simplest technique a flat film placed behind the specimen perpendicular to the direction of the X-ray beam records a series of concentric rings. Alternatively, the film may be placed so that the primary X-ray beam has to pass through the film before striking the specimen, the back-reflexion method. Of widest application perhaps is the cylindrical powder camera, in which narrow strips of film on its periphery almost surround the specimen which is mounted on its axis. The X-ray pattern consists then of slightly curved lines, is unique to each crystalline element or compound, and hence may be employed as a crystal 'fingerprint' for identification purposes.

Very careful design of cylindrical powder cameras is required in order that patterns of high definition and clarity should be obtained. For example, it is essential to ensure that after collimation the primary X-ray beam travels through the camera without impinging upon any other part. Usually knife edges are arranged to record fiducial shadows on the film at a diffraction angle of approximately 85°. This enables accurate measurements of interplanar spacings to be made and errors due to film shrinkage, mounting of specimen, etc., to be avoided[3,4]. The powder is attached with an adhesive medium to a fine glass fibre or hair and rotated continuously on the camera axis during the exposures. Displacing the air in the camera with hydrogen is advantageous because this appreciably reduces general scatter of the X-radiation near the lower angles of diffraction. It is useful to have available two cameras of different diameters, for example, 10 cm. and 19 cm. respectively. The larger camera naturally increases the separation of the diffraction lines.

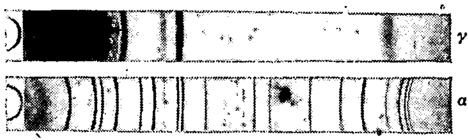
Applications of X-Ray Crystal Analysis

Identification is to a large extent achieved by comparison of the pattern of the specimen with standard X-ray patterns of known pure substances, and it is desirable to possess as large a collection as possible of standard photographs. Generally, the origin and the chemical or spectroscopic analysis of a specimen will suggest likely substances and set a limit to the possibilities, but the experience and memory of the investigator will enable much time to be saved in any given search. It would be advantageous to have a reference index in terms of interplanar spacings for as many powder photographs as possible, with a master table, for example, of two or three of the strongest lines in each. There are very considerable difficulties, however, in making the index sufficiently comprehensive.

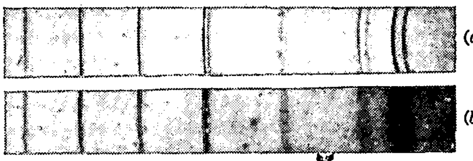
The strengths of the respective X-ray patterns from the components of a mixture are dependent upon the relative amounts present, so that a quantitative determination of composition can be made. Usually the accuracy is not very high, partly because of some uncertainty in the estimation of line intensities, but for small concentrations of one phase in another the estimation may frequently be made to 1–2 per cent.

Far from being the only application of X-ray powder photography, formal identification of a chemical compound may be but the initial step in an investigation. It is the more subtle information so readily given by the X-ray technique that is frequently of such great importance. In the first place, we often wish to distinguish between different crystalline varieties of a substance, and since it is the atomic arrangement that determines the form of the X-ray photograph, true crystalline modifications will give distinctive X-ray patterns. In the case of silica there are three polymorphic forms stable at ordinary temperatures, namely, quartz, cristobalite and tridymite. Silica bricks are employed extensively as refractories in glass and steel furnaces; the raw material is quartz and the bricks must be fired at high temperatures before use to convert most of the quartz to cristobalite and tridymite. Although the chemical composition of the brick remains unchanged, X-ray examination shows when the change in crystal form of the silica has taken place.

Mixed crystal or solid solution formation is readily revealed by X-ray powder photographs. With a continuous series of solid solutions the end members of which are isomorphous, the dispersion of the lines of the X-ray patterns usually changes systematically with composition. Such a series is formed between barium and strontium carbonates, the compounds used in the preparation of the alkaline earth oxide-coated cathodes for thermionic devices. It is often necessary to determine the composition of such oxide coatings after operation, and since the amount of material is usually extremely small and the separation of barium and strontium difficult by the more usual chemical analytical methods, X-ray analysis has been applied. The ratio of barium to strontium is determined by measuring the displacement of the X-ray pattern of the thermionic cathode coating in the form of carbonate from the patterns of the individual carbonates of strontium and barium. The study of alloys or the solid solutions formed between elements is one of the most important applications of X-ray analysis; extensive examinations have been made of ternary alloys, where complex problems of equilibrium arise and the distinction between the various phases is difficult or impossible by microscopic or other methods[5,6].



X-RAY POWDER PHOTOGRAPHS (10 CM. CAMERA, COPPER $K\alpha$ RADIATION) OF γ AND α FORMS OF ALUMINA, ILLUSTRATING LARGE DIFFERENCE IN ULTIMATE PARTICLE SIZE.



PARTS OF X-RAY POWDER PHOTOGRAPHS (19 CM. CAMERA, COPPER $K\alpha$ RADIATION) COMPARING (a) SODIUM CHLORIDE ANNEALED AT 450° C. WITH (b) SODIUM CHLORIDE AFTER SEVERE GRINDING.

If the average crystal size of a powder falls below a certain value, the lines of the X-ray pattern become broadened, and for very small crystals the lines are so broad as to be better described as diffraction bands. The amount of the broadening may be measured and used to calculate the average crystal size. Characteristic chemical or physical properties of a material may often be dependent upon ultimate crystal size rather than upon aggregate particle size. The γ form of alumina, for example, is used as an absorbent for water vapour in gas dryers, when it is frequently referred to as 'activated alumina'. The high absorptive properties are associated with the fact that this form of alumina, as usually prepared, consists of extremely small crystals, some 40–50 A. in size, the X-ray powder photograph showing very diffuse lines compared with the sharp lines on the pattern of the relatively inactive α alumina.

Broadening or diffuseness of the X-ray lines may also be associated with what is called lattice strain or lattice distortion. Such distortion is present in filings from a metal or in a powder which has been severely ground. The presence or absence of strain is best examined in the back-reflexion region of the X-ray pattern, where the normally sharply resolved α doublet lines of the characteristic radiation may become fused into a broad unresolved reflexion. It is often required to test the efficacy of heat treatments in freeing a metal from strains introduced by particular mechanical processes, and here the detection of lattice distortion by X-rays is of great practical importance. In the manufacture of alloys of nickel and iron in powdered form for use at high frequencies in various types of magnetic loading and radio cores, it is inevitable that high degrees of lattice strain are introduced and this must be reduced to a minimum to obtain the magnetic characteristics required. By examining the resolution of the lines on the X-ray patterns of powders after heat treatment at successively increasing temperatures, it is possible to determine at what stage the strain is eliminated, and so an appropriate 'annealing' schedule can be chosen. Moreover, by the examination of finished powder, variations in the manufacturing conditions are quickly revealed.

The examples given here are but a random selection from the very many and varied applications of X-ray technique. They should, however, enable some picture to be formed of the extensive manner in which X-ray methods may be utilized in the industrial laboratory.

[1] *Mechanical Engineering*, p. 906, Dec., 1941.

[2] Seemann, H. E., *Proc. Amer. Soc. Testing Materials*, **38**, 284 (1938).

[3] Bradley, A. J., and Jay, A. H., *Proc. Phys. Soc.*, **44**, 563 (1932).

[4] Lipson, H., and Wilson, A. J. C., *J. Sci. Inst.*, **18**, 144 (1941).

[5] Bradley, A. J., Bragg, W. L., and Sykes, C., *J. Iron and Steel Inst.*, **141**, 63 (1940).

[6] Lipson, H., NATURE, **146**, 798 (1940).

MEASUREMENT OF RADIATION FOR MEDICAL PURPOSES*

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THE methods of measuring radiation for any purpose must in the end be determined by the fact that we are concerned with a form of energy. In particular, the biological or medical use of radiation is dominated by the rule that absorbed energy alone is effective, so that we are forced in considering the physical aspects of the use of radiations for these purposes to look very closely into the measurement of absorbed energy.

Considering the case of X rays first of all, it has for many years been recognized that the most promising basis on which to construct a system of measurement is the ionization produced by them in air, and since 1928 the röntgen based upon this finding has been used as the internationally accepted unit of dose. In 1937, as the result of a good deal of experimental and theoretical work, the use of the unit was extended to gamma rays, and a new definition of the röntgen was promulgated. The fundamental idea, namely, that we take all the electrons set free by the radiation from a certain mass of air, utilize as much as possible of their energy in producing ionization in air and measure the number of electrostatic units of charge thus liberated, appears much more clearly in the new definition.

Having in this way obtained a suitable unit, it was natural to apply it to medical problems, in particular to that of finding the dose at any point throughout the tissues of the body. First of all, the distribution of radiation along the axis of a beam of X rays was studied over a very wide range of conditions from 10 kv. up to some 2,000 kv., and so a large amount of useful information was collected concerning the effective penetration of the beams. Later the studies were extended to include the complete three-dimensional problems of distribution and the study of 'isodose surfaces'. Simple geometrical methods of dealing with these problems were demonstrated, and it is possible by the use of plaster casts to estimate fairly closely the dose received at any given point within any arrangement of beams of radiation, however inclined or concentrated. Alternatively, the best arrangement of beams of radiation in order to produce the maximum dose at the point desired while at the same time keeping down the dose to normal healthy tissue, may be investigated.

So far we have been concerned with the amount of radiation at a particular element of volume, but it is important to develop this study so as to estimate the total energy absorbed by the body as a whole, the estimates of energy absorption to be made if possible in absolute energy units.

It will be recognized that the röntgen is essentially a unit of energy absorption in air, the factor of proportionality depending upon the energy required to produce one ion pair. If this energy is 33 electron-volts, it follows that when 1 röntgen is delivered to 1 gm. of air there will be an absorption of energy of about 85 ergs. For soft animal tissues the value will vary a little with wave-length, but for many purposes may be assumed to be equal to this amount. For the further development of the theory it is also necessary to consider the relationship between the intensity of a beam of X or gamma rays in ergs/cm^2.sec. and the dosage-rate, that is, r./min. Evidently the relationship depends upon the wave-length of the radiation, and it is easily calculated that whereas the energy flux per cm^2. per röntgen for gamma rays is of the order of 3,000 ergs, for long wave-lengths of the order of 1 A. the corresponding number is about 30 ergs. The distinction between intensity and dosage-rate is a very important one, which is all too frequently neglected in theory and practice.

In considering some of the effects of radiation, it seems that the total energy absorbed throughout the body is a very important quantity. The distribution studies of dose, the isodose surfaces, coupled with the deduction of the energy absorbed per gm. per röntgen, enable estimates of the energy absorbed to be made. We have used as a unit the energy absorbed when 1 röntgen is given to 1 gm. of air, and called it 1 gram-röntgen. In clinical practice a megagram-röntgen is of a convenient order of size and may be shown very easily to be approximately 2 gm.cal.

Again, by geometrical and analytical methods (assuming simple laws of variation of radiation with depth) the integration of the energy absorbed throughout any part of the body may be carried out, and so the total energy absorbed may be estimated. This has been done for a number of conditions occurring in practice and it is found that the physical results are very instructive in relation to the clinical findings. As an example of the kind of problem in which the results are significant, we may quote the problems of the protection of staff and patients from unwanted radiation, where the differences now revealed in the total energy absorbed in the body as a whole per unit dose on the skin raise the question of the assumed independence of 'tolerance dose' of wave-length. By the use of large numbers of pressed bakelite - carbon condenser ionization chambers throughout a model of the body, this subject is being investigated further.

* Substance of a lecture delivered to the Physical Society on Feb. 27.

Having obtained estimates of the energy flux into the body and of the energy absorbed from beams of X and gamma rays, it is natural to attempt the corresponding solution for ultra-violet and infra-red rays. By the use of calibrated thermocouples, information on this subject may be obtained, and indeed in the case of ultra-violet light a good deal is already available. It seems that the total energy absorbed per square centimetre of the body when irradiated with ultra-violet light so as to produce a threshold erythema is of the same order as that given when 100 r. of medium wave-length X rays is administered. For infra-red radiation very little information was available, but we have used suitably mounted calibrated vacuum thermocouples (General Electric type) and made measurements of the intensities required for a painful sensation and of the intensities normally employed in therapy. The values of these quantities are found to vary with the colour temperature of the source, the normal intensity for a 500-watt tungsten filament lamp in a reflector being of the order of 1·5 gm.cal./cm^2.min.

Finally, then, we see the order of intensities and amounts of energy involved in the use of different kinds of radiations.

(*a*) Type of radiation.			Intensity in ergs/cm.^{2}sec.
High-voltage X rays. Heavy filter	200 kv.	40 r./min.	2×10^3
Ultra-violet light		20 μ watts/cm.^{2}	2×10^8
Infra-red		1 gm.cal./cm.^{2}min.	7×10^5

(*b*) Type of radiation			Total energy absorbed
High-voltag e X rays	200 kv.	30 megagram-röntgens.	60 gm.cal. in 6 weeks.
Ultra-violet light		Erythema over body surface of 1,500 cm.^{2}.	8 gm.cal. at a sitting.
Infra-red		1 gm.cal./cm.^{2}min. 20 min. Area 1,500 cm^2.	3×10^4 gm. cal. at a sitting.

The intensities are approximate but of interest in the correlation of all the radiations on an energy basis.

OXIDATION OF HYDROCARBONS AT LOW TEMPERATURES

By P. GEORGE, PROF. E. K. RIDEAL, F.R.S., and A. ROBERTSON

Department of Colloid Science, Cambridge

FARMER and Sundralingam in a recent paper[1] have stressed the part that hydroperoxides play as the first isolatable intermediates in autoxidations: their investigation, anticipated by Criegee, showing that olefin peroxides have the structure $-CH(OOH)-CH{=}CH-$, brings these peroxides into line with Rieche's alkyl peroxides, possessing the reactive group ($-OOH$). The work reported below on the uncatalysed and the heavy-metal catalysed oxidation of alkyl benzenes and long-chain saturated aliphatic hydrocarbons (C_{15} to C_{25}) in the liquid phase at 100–120° C., also supports the hypothesis that hydroperoxides are primary oxidation intermediates.

The Chain Character of the Reaction

In the case of alkyl benzenes the peroxide found after reaction corresponds to 60–80 per cent of the oxygen absorbed. The peroxides of long-chain paraffins are not so stable; and they are only found in small concentration, about 5 per cent. In the metal-catalysed oxidation good agreement is obtained between the observed peroxide concentration and that calculated from the efficiency of the catalyst in peroxide decomposition.

In the catalysed oxidations a curious independence of oxidation-rate of catalyst concentration was found above a certain value. This has been reported in other autoxidations, notably benzaldehyde catalysed by ferrous phthalocyanine[2] and linseed oil catalysed by hæmoglobin[3]. The explanation advanced was low oxygen availability due to physical conditions. This cannot be the case here, for the rate of oxidation has been found proportional to the partial pressure of oxygen. The curves obtained for long-chain paraffins catalysed by cobalt stearate and ethyl benzene catalysed by copper stearate are shown in Fig. 1.

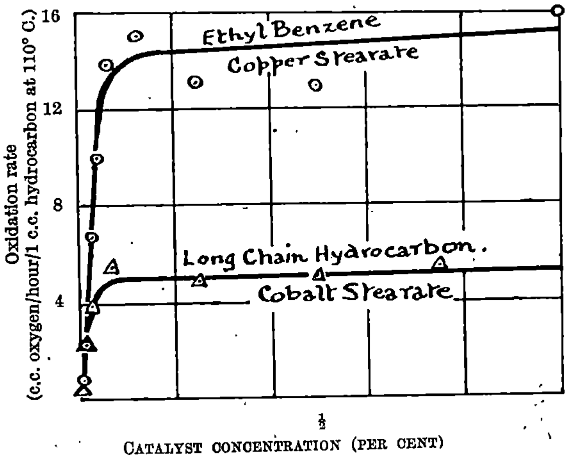

Fig. 1.

This can be explained by the hypothesis of a chain mechanism in which the metallic catalyst both starts and stops chains. This gives the expression:

$$\text{Rate of oxidation} = \frac{a + bY}{c + dY} \quad . \quad . \quad . \quad (1).$$

Y is the catalyst concentration, a the number of chains started per unit time in the uncatalysed reaction, b the number started per catalyst molecule $1/c$ and $1/(c + dY)$ the uncatalysed and catalysed chain lengths respectively.

The chain character of the oxidation has been demonstrated by inhibition with β-naphthol. It causes a marked diminution in the oxidation rate of alkyl benzenes, the rate slowly increasing with time. For catalysed long-chain paraffins complete induction periods lasting for 2–6 hours with no measurable oxygen uptake are observed, even with a 2–50 molar excess of catalyst over inhibitor. Equations have been developed to calculate the chain length from this diminished rate or induction period data. A surprising specificity of catalysts is shown by the following experimental results:

(*a*) Copper stearate catalyses the oxidation of ethyl benzene and tetralin, but not long-chain paraffins, whereas cobalt stearate is as efficient a catalyst for all three.

(*b*) Copper stearate added to cobalt-catalysed long-chain paraffin diminishes the rate.

(*c*) Copper stearate diminishes the uncatalysed rate of octene mixtures.

All these phenomena are explicable on the assumption of different chain-starting and chain-stopping efficiencies. From equation (1), if b/d is *greater* than a/c, then the metal is a positive catalyst, whereas if b/d is *less* than a/c it is an inhibitor.

Farmer[1], Cook[4] and others have shown that heavy metal catalysts decompose hydroperoxides giving mainly ketones and alcohols. Kinetically, the decomposition of tetralin peroxide is unimolecular, the reaction constant being proportional to catalyst concentration. This suggests a 'metal catalyst hydroperoxide complex' breakdown. The efficiency of a catalyst as a chain stopper is paralleled by its effect as a catalyst in the decomposition of hydroperoxides. A kinetic study suggested that in catalysed oxidations the relation

$$\frac{dx}{dt} P = \alpha Y$$

should hold, where $\frac{dx}{dt}$ is the rate of oxidation, P the equilibrium peroxide concentration and Y the catalyst concentration. This was found to be so. The constant α gives a measure of peroxide reactivity.

The Oxidation Intermediates

In the case of long-chain paraffins, the following experiments indicate that these alkyl hydroperoxides decompose almost exclusively to give ketones.

Both primary and secondary alcohols have a very slow oxidation-rate compared with other long-chain derivatives. The following oxidation rates are measured at 110° C. and are in cubic centimetres oxygen per hour per 1 c.c. solution.

Type of compound	Uncatalysed rate	Catalysed rate with ½ per cent cobalt stearate
Sec. octyl alcohol ...	0·06	0·2
Cetyl alcohol	0·08	0·8
Long-chain paraffin ...	0·25	4·5
Laurone	2·6	8·6
Stearic acid	0·5	9·0

If alcohols were intermediates, the oxidation would tend to slow down markedly and alcohols would preponderate in the product. Furthermore, by oxidizing a mixture of hydrocarbon with a secondary alcohol (the type of alcohol produced by oxygen attack on a $-CH_2-$ group) ketone or acid, the results shown in Fig. 2 are obtained.

It is apparent that secondary alcohols inhibit the oxidation of hydrocarbons just as β-naphthol does, though not to such a marked degree; 10 per cent of alcohol produces an induction period of at least 6 hours and 25 per cent for at least 24 hours. This is very strong evidence that the oxidation does not proceed via alcohols, and so Bone's hydroxylation theory does not apply in these low-temperature liquid phase oxidations. The curves for acid and ketone mixtures indicate that these are also chain processes. The shape of the ketone-hydrocarbon curve indicates that the ketone oxidation chain-length is greater than the hydrocarbon oxidation chain-length. The converse holds for the acid-hydrocarbon curve.

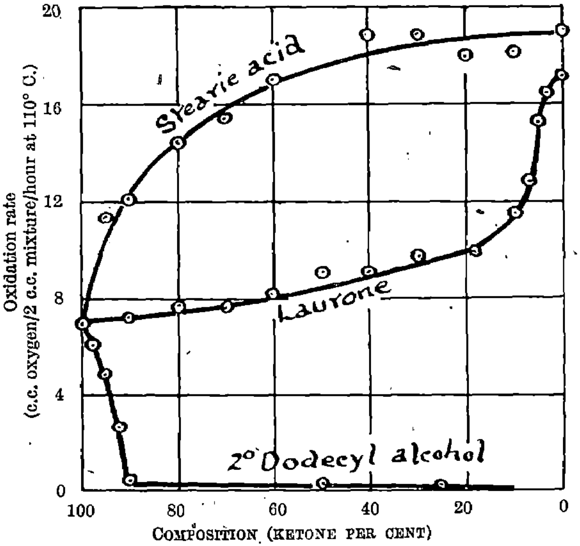

Fig. 2.

The Nature of the Catalyst

The function of the metallic catalyst in hydrocarbon oxidation is thus shown to be threefold: to start and stop reaction chains leading to the production of hydroperoxides, and to decompose the peroxides. It has been suggested in the past that the catalytic activity is due to the heavy metal ion. However, a vast number of co-ordination compounds act as catalysts[5], among them porphyrins[6] and phthalocyanines[2], and the assumption that their varying catalytic activity is due to their differing degrees of electrolytic dissociation is contrary to their physical properties and stereo-chemical behaviour. The real problem now is to decide which of the transition element properties—whether complex formation or valency change—is responsible for the chain-starting and chain-stopping process. The rates of the catalysed oxidation of tetralin and paraffinic hydrocarbons are proportional to the partial pressure of oxygen, which implies that the oxygen molecule is involved in the chain-starting process. This favours complex formation. A study of some sixty catalysts suggested that all the good catalysts are ionic complexes, which would be the case if the required bonding of the oxygen molecule were similar to that in oxyhæmoglobin, where paramagnetic hæmoglobin combines with paramagnetic oxygen giving diamagnetic oxyhæmoglobin[7].

In an attempt to poison this heavy metal catalysis with carbon monoxide, it was found to be oxidized to carbon dioxide[3]: control experiments showed this to happen only in the presence of oxidizing hydrocarbon. It is hoped that this will help in the future to elucidate the chemical nature of the chain process.

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[1] Farmer and Sundralingam, *J. Chem. Soc.*, 121 (1942).

[2] Cook, *J. Chem. Soc.*, 1770 (1938).

[3] Robinson, *Biochem. J.*, **18**, 255 (1924).

[4] Cook, *J. Chem. Soc.*, 1774 (1938).

[5] Gebauer-Fuelnegg and Konopatsch, *Ind. Eng. Chem.*, **23**, 163 and other papers (1931).

[6] Guzman Barron, Symp. Quant. Biol., **7**, 154 (1939).

[7] Pauling and Coryell, *Proc. Nat. Acad. Sci.*, **22**, 210 (1936).

SCIENCE AND ART AT THE ROYAL ACADEMY, 1942

By DR. A. T. HOPWOOD
British Museum (Natural History)

WHEN reviewing last year's Summer Exhibition at the Royal Academy, I ventured to say that since intellectual honesty is at the foundations of both science and art, there is no fundamental distinction between them, and that apart from the objectivity of the one and the subjectivity of the other the differences are mainly those of design, of technique, and of the medium of expression. I did not attempt to define what art is because there is so much difference of opinion among professional critics, to say nothing of the disagreements to be found among painter-writers, that it seemed presumptuous for a zoologist to try to do so. On the other hand, it is but just to the artist that the critic should explain his methods so far as in him lies, and this entails an effort to define his terms.

Now a painting, a drawing, or a piece of sculpture is a report on its maker's activities. It differs from a scientific report because it records the emotions of its author, and also reveals his personality. The more sincere it is, the more complete will be the revelation of the artist's emotional personality; if this is not so the result is meaningless. When looked at intelligently, and there is a great difference between looking at an object and understanding it, it becomes a work of art to the degree in which it succeeds in conveying the artist's meaning to the mind of the beholder.

For example, at the present Exhibition "Stone Walls, Yorkshire" by Sidney Lee (No. 103) is to me a work of art because it conveys the feeling and spirit of the landscape in the Millstone Grit regions of the Pennines; but if another fails to respond to the picture, then not all the technical merit in the world will make it a work of art for that person. Again, "The Coaster" by Arthur B. Cornwell (No. 323) is likewise a work of art for much the same reason; it makes an immediate appeal to all sailors and also conveys a vivid impression of stormy coastal waters of Great Britain to those unfamiliar with them in a way that no photograph could ever do. The artist has succeeded in capturing the mood of the storm and recording it in paint. These are simple examples, but what is to be made of "Wet Fish on Tilted Tray" by Frank Goulding (No. 332)? Here we are confronted with the adumbration of a number of forms which the artist avers to be fish; fish, be it said, such as no fisherman ever saw. What then was the intention of the artist? It may be that this is a report on some experiment which I cannot understand, but it is certain that it conveys nothing to me, and therefore is not a work of art for me.

Art, then, depends on the co-operation of two persons, the artist and the spectator. When the artist succeeds in expressing the emotional imagery conjured up in his mind by a given set of circumstances in such a way that their depth and intensity are communicated to the spectator, he has achieved art. But the spectator, too, must do his share, for, to quote Sir Joshua Reynolds, "It is the lowest style only of the arts that may be said in the vulgar sense to be naturally pleasing. The higher efforts of those arts do not affect minds wholly uncultivated". Which is not so far removed from Mr. Roger Fry's dictum that "In proportion as art becomes purer the number of people to whom it appeals gets less and less. It appeals only to the æsthetic sensibility, and that in most men is comparatively weak".

If the current Exhibition is approached in some such frame of mind as that indicated in the preceding paragraphs; if the scientific man will visit the Royal Academy with the intention of examining the pictures instead of just going to see them, he will find plenty to interest him. For the zoologist it is easy, and not very clever, to walk round noting that "Peregrine Falcon" by C. F. Tunnicliffe (No. 397) is not correctly coloured; that the pochard in "Good Companions" by Jessie Hodge (No. 391) has a lack-lustre eye; and that a Suffolk Punch, or what appears to be intended for such, is scarcely an appropriate mount for a cavalryman (No. 752). The botanist will find numerous flower pieces to criticize but very little fruit or vegetables. As for the war pictures, they are of general interest. There are portraits for the social historian; aeroplanes for the aeronautical engineer; ships for the navigator; bomb-scarred buildings for the architect and town-planner; and so on. Many of these reach a high level of competence, indeed as reporting they are often first-rate, but the damning entry "Painted for the Nation's War Records" attached to some of them explains a lot, and probably "Painted as a War Record" should be attached to the majority. They often lack inspiration and feeling.

Two war pictures are an exception. Ugly in themselves, unpleasant in colouring, and inaccurate in drawing as they are, they are perhaps the most successful works in the whole Exhibition. These pictures are: "Clydebank; a Tribute", by Hugh Crawford (No. 108) and "Military Objectives" by Louis Duffy (No. 183). The first conveys the doggedness of the civil population in war-time, and the second the dull misery of the bereaved. These are symbols, poignant symbols, of the horrors of aerial bombardment, and as such their essential truth is startling and vivid. Where these two artists have triumphed, Charles Wheeler has failed. His allegory, "Wings" (No. 128), is confused alike in message and design. The winged figure to the left does not carry the conviction of the angels of Fra Angelico, or, for that matter, of the devils of Dürer and Martin Schongauer, all three of whom believed in their images; but one doubts whether Mr. Wheeler believes in his.

On the whole, however, the psychologist probably has the lion's share of this Exhibition, as of many others. He will soon discover that A. J. Munnings is so interested in figures, particularly horses and their riders, that almost any sort of a smudge will do for the rest; "Start at Newmarket" (No. 1) and "A Swimming Pool" (No. 115) illustrate this point. Gerald Kelly is obviously interested in people, but not to the detriment of their setting; indeed the care with which the quiet backgrounds are painted only serves to emphasize the importance to be attached on the subject, and the unobtrusive prominence accorded to the hands indicates his confidence and skill. Augustus John shows himself still to be a romantic at heart, more at home with a subject such as "The Mask" (No. 106) than with an official portrait (No. 110). So one might go on through the catalogue, and so the visitor should go on for himself.

Most of the exhibits in the Architectural Room are of public buildings. The most interesting are the drawings of some portions of the Anglican and Roman cathedrals at Liverpool by Sir Giles Gilbert Scott and Sir Edwin Lutyens respectively; they are hung side by side (Nos. 704 to 708) so that comparison is made easy. Plans for domestic dwellings are few, but protest must be made against No. 666, "War-time Housing on the Wirral"; not even war-time can excuse the mechanical dullness of these brick boxes.

Much of the sculpture is pleasant and intimate although not profound. Particular mention may be made of "Head of Young Bull" by Georg Ehrlich (No. 817), the "Leopard" by Hermon Cawthra (No. 796), and "Siamese Cat" by Margaret Heaton (No. 820). "Cart-horse Lying Down" by Tonie Brignall (No. 818) is stylized but not unsuccessful.

On the whole, then, there is little of primary scientific interest in this year's Academy, but this is all to the good. The natural reaction to a picture of 'scientific interest' is to examine it for its accuracy—the science comes before the art; but this year science takes a back seat and her devotees can give themselves up to the pleasure of getting on good terms with the exhibits and, through the exhibits, with their authors. Viewed in this light, the Summer Exhibition of the Royal Academy of Arts, 1942, is very much to be commended.

OBITUARIES

The Rev. T. E. R. Phillips

It is with great regret that we record the death of the Rev. T. E. R. Phillips, so soon after the University of Oxford had conferred on him an honorary D.Sc.

Theodore Evelyn Reece Phillips, the son of the late Rev. Abel Phillips, was born on March 28, 1868, and was educated at Yeovil Grammar School. He proceeded later to St. Edmund Hall, Oxford, and graduated B.A. in 1891, in which year he was ordained to the curacy of Holy Trinity, Taunton. He took his M.A. in 1894 and two years later, while curate at Hendford near Yeovil, he used a 9¼-inch altazimuth reflector for the systematic observation of the planets, especially Mars and Jupiter. This work was continued when he moved to Croydon, and when he was appointed curate at Ashtead in 1906 a 12¼-in. equatorial reflector by Calver was substituted for the 9¼-in. An 8-in. refractor by Cooke, which was lent to him by the Royal Astronomical Society in 1911, was used for about thirty years, chiefly for double-star work.

In 1916 Phillips was appointed rector of Headley, and he set up an observatory in the rectory glebe where, in addition to the instruments referred to, an 18-in. reflector (mirror by With), lent by the British Astronomical Association, was mounted on the equatorial stand which had previously carried the 12¼-in. reflector. This 18-in. reflector was used mostly for planetary work and especially for investigating the surface currents on Jupiter.

A short record of Phillips's work on the planets, double-star measurements and light curves of long-period variables appeared in NATURE of February 28 (p. 241), and it is unnecessary to repeat this. Some reference may be made to his analysis of the light-curves of long-period variables, which he undertook on the suggestion of the late Prof. H. H. Turner about thirty years ago. He conducted a harmonic analysis of the light-curves of nearly eighty stars, and a full account of this appeared in his second presidential address to the British Astronomical Association (*J. Brit. Ast. Assoc.*, 27, 1; 1916). In this address he referred to his work on *S.* Herculis (*Mon. Not. Roy. Astro. Soc.*, **75**, 7), where he had gone as far as the fifth harmonic. He felt that certain assumptions were adding encumbrances to the problem and remarked ". . . we have now reached a stage when the theory of stellar variation calls for reconsideration and revision".

In addition to his interest in planetary features, variable stars and double stars, Phillips was a keen meteorologist and was elected a fellow of the Royal Meteorological Society in 1918. He kept an unbroken record of daily temperature and rainfall at Headley for twenty-five years and was working on the results before his death. He was analysing harmonically a large number of temperature curves for the British Isles and hoped to publish the results after the War. He was also interested in botany, more especially in British and Alpine flora, as well as in sketching, and he took an active part in the preservation of the countryside.

Phillips was a member of Commission 16, which is specially concerned with the physical study of the planets, of the International Astronomical Union, and was president for some years. In 1922 he was appointed by the late Archbishop Davidson as his representative on behalf of the Church of England to consider the stabilization of Easter. Later he sat on the special committee of six formed by the International Union to consider calendar problems in general. For many years he was a university extension lecturer for Oxford, Cambridge and London, and also Gilchrist Trust lecturer. In connexion with the British Astronomical Association he was director of the Jupiter Section, 1900–33, director of the Saturn Section, 1935–40, president during 1914–16, and recipient of the Walter Goodacre Medal and Gift in 1930. In 1918 the Royal Astronomical Society awarded him the Jackson-Gwilt Gift and Medal. He was secretary of the Society during 1919–26 and president during 1927–29. In February of this year, Oxford conferred on him the degree of D.Sc. *honoris causa*, an honour which he greatly appreciated.

His published works include his revision of Ball's "Popular Guide to the Heavens", and "Astronomy and Modern Thought". In addition to these, he collaborated with Dr. W. H. Steavenson in editing "Splendour of the Heavens", 2 vol., and he contributed articles in the "Encyclopædia Britannica" on "Planets".

Phillips's genial disposition made him very popular in astronomical circles, where he will be greatly missed. During his illness many anxious inquiries were made about his progress and there were hopes that he might rally and attend the meetings again, but early in May it was known that his condition was extremely grave, and he died on May 13. The interment took place at Headley on May 16, when a number of astronomical and other friends were present. In 1906 he had married M. H. Kynaston, who, with a son, survives him. M. DAVIDSON.

Mr. W. A. Douglas-Rudge

WE regret to record the death, on February 14, of Mr. W. A. Douglas-Rudge, late science master of Rugby School. Mr. Douglas-Rudge was a scholar of

St. John's College, Cambridge (B.A., 1899; M.A., 1903), where he obtained a first class in Part I of the Natural Sciences Tripos. He was science master of Woodbridge School from 1903 until 1907, when he was appointed professor of physics at University College, Bloemfontein. During his residence in South Africa he made a special study of atmospheric electricity in that part of the world. Several of his papers were published in the *Transactions of the Cambridge Philosophical Society*. He returned to Great Britain and was appointed science master at Rugby in 1916, a post which he held until his retirement at the end of 1930. Many of his old students at Woodbridge, Bloemfontein and Rugby will remember with gratitude his inspiring lectures, which were always illustrated with many experiments.

NEWS and VIEWS

U.S. National Academy of Sciences: Elections

The following elections were made at the annual meeting of the U.S. National Academy of Sciences held during April 27–28: *Foreign Secretary* (to succeed the late Prof. L. J. Henderson): Prof. Walter B. Cannon, Harvard Medical School, Boston, Massachusetts (term: four years ending June 30, 1946); *New Members of Council*: Prof. George W. Corner, professor of anatomy, Strong Memorial Hospital, Rochester, N.Y.; *Foreign Associate*: Prof. Robert K. S. Lim, professor of physiology, Peiping Union Medical College, Peiping.

Members of the Academy: Prof. Homer Adkins, professor of chemistry, University of Wisconsin, Madison, Wisconsin; Dr. Lyman J. Briggs, director, National Bureau of Standards, Washington, D.C.; Prof. H. T. Clarke, professor of biochemistry, Columbia University, New York City; Prof. Ralph E. Cleland, Indiana University, Bloomington, Indiana; Prof. C. H. Danforth, professor of anatomy, Stanford University, California; Prof. C. A. Elvehjem, professor of agricultural chemistry, University of Wisconsin, Madison, Wisconsin; Prof. Michael Heidelberger, professor of biochemistry, Columbia University, New York City; Prof. John Gamble Kirkwood, Cornell University, Ithaca, New York; Dr. Paul D. Merica, metallurgist, 67 Wall Street, New York City; Dr. Thomas Midgley, jun., chemist, Worthington, Ohio; Prof. Francis D. Murnaghan, professor of applied mathematics, Johns Hopkins University, Baltimore, Md.; Dean John T. Tate, professor of physics, University of Minnesota, Minneapolis, Minnesota; Prof. Alfred M. Tozzer, professor of anthropology, Harvard University, Cambridge, Massachusetts; Prof. E. E. Tyzzer, George Fabyan professor of comparative pathology, Harvard Medical School, Boston, Massachusetts; Prof. S. A. Waksman, professor of soil microbiology, Agricultural Experiment Station, New Brunswick, New Jersey. Prof. Albert Einstein, professor of mathematics, Institute for Advanced Study, Princeton, New Jersey, was also elected a member; his status as a foreign associate, dating from 1922, before he became an American citizen, will not be affected by the new election.

History of Science in Scotland

The Regional Committee for Adult Education of the University of St. Andrews has followed up the issue of twelve pamphlets on "Britain and its People" by the publication of a further dozen under the general title "Scotland and its People". These pamphlets provide, in a very readable form, much general information about Great Britain, and particularly about Scotland. Through the help of the Pilgrim Trust, it has been possible to distribute them free of charge to members of H.M. Forces and Allied troops. Among the titles in the second series are "The History of Science in Scotland", by Sir D'Arcy Thompson, "Scotland and Advances in Medicine and Surgery", by Dr. J. Patrick, "The Scottish Universities", by Sir James Irvine, and "Scottish Agriculture and Industry", by Mr. J. W. Nisbet. In his rapid survey of Scottish science Sir D'Arcy Thompson points out that Napier of Merchiston was the first true man of science in Scotland since Michael Scot. Soon after Napier's death, began the long line of "academic Gregories", contributing some fourteen professors of mathematics, medicine and chemistry to the Scottish universities during the succeeding two hundred years. "There is hardly such another instance known of scientific heredity, unless perhaps that of the Cassinis, who directed the Paris Observatory for nearly as long." John Napier, James Gregory, Colin Maclaurin and James Stirling are characterized as the four great Scottish mathematicians; "but there came after them many a good man", including Ivory and Tait.

Among outstanding figures in chemistry are Black, Graham, Couper, Dewar, Ramsay and James Young; in physics and engineering, emphasis is laid upon Watt (whom Davy likened to Archimedes), Robison, Russell (the builder of the *Great Eastern*), Brewster, Clerk Maxwell and Lord Kelvin. Of the last-named Sir D'Arcy writes: "Somehow he is not quite so great, he is not near so lovable, as Clerk Maxwell; but his achievements were in touch with the spirit of his time, and his fame was prodigious." In astronomy, John Lamont of Braemar became Johann von Lamont, head of the Munich Observatory and an authority on terrestrial magnetism, and with him are mentioned Broun, Buchan and Henderson. Geology is represented by James Hutton, 'the father of modern geology', and many another; for "Scotland has done so much for geology that this science seems peculiarly her own". Finally, in natural history and botany we encounter Sir Robert Sibbald, founder of the Edinburgh medical school, Goodsir the anatomist, Edward Forbes, Wyville Thomson, and Robert Brown of Montrose—Humboldt's *facile princeps botanicorum*. One lays down this attractive and admirable account with a lively sense of the truly remarkable nature of Scotland's contribution to pure and applied science.

Irish Sea and Inland Fisheries

A very satisfactory state of affairs is shown in the report of the Minister for Agriculture (Eire) on the sea and inland fisheries for 1940. The yield of sea fish exceeded that of any year since 1930 and was appreciably larger and of greater value than in 1939. The position has been affected materially by the work of the Irish Sea Fisheries Association, Ltd., which began to function in 1931, and during the period intervening was engaged in the provision and equipment, on hire-purchase terms, of more than 130 motor-vessels which constitute the bulk of the existing fishing fleet. The larger landings in the year are attributable mainly to the efforts of the inshore fishermen, who found themselves well equipped at the onset of war conditions which have caused such a radical change in the operation of supply and demand for the output of sea-fishing in common with other food-producing industries. The increased earnings now obtainable are attracting more and more men.

The Dingle fishermen again did remarkably well, and their landings were just double the value of those of the preceding year. The summer and winter herring fishery, contrasted with 1939, showed quantitative increases of 21 per cent and 56 per cent respectively. The catches of salmon and sea-trout are better than those of the three preceding seasons, but are still below the average for the previous four decades. The drift-net fishings for salmon off the north and north-west coasts were also below average. The spawning season was a good one in nearly all fishing districts and the run of smolts, so far as was ascertainable, up to the average of previous years. The bad weather, however, interfered seriously with hatching experiments, although the output from the experimental brown trout hatchery at Lough Owel was nevertheless the highest yet recorded.

Meteorology in Iraq

THE fifth annual report of the Director of the Meteorological Service of the Government of Iraq, which covers the year ending March 31, 1941, describes the work of this Service during a period when it was much affected by the entry of Italy into the War on June 10, 1940. The amount of civil aviation in Iraq was greatly reduced, but the companies still carrying on were supplied with reports and forecasts on the usual lines. The greatest difficulties arising from the entry of Italy into the War were in connexion with supplies of equipment from Great Britain. The supply of balloons required for making observations of the upper winds became erratic, and larger reserves had to be built up, which gave rise to problems of storage in a climate very unfavourable for rubber storage. The experiment was made of getting balloons made in Australia and the United States. In both cases results were satisfactory apart from the extra expense.

Other innovations included the making of the hydrogen required for the balloons on the spot with the aid of French generators employing ferro-silicon, and the construction by the Ordnance Department of Stevenson screens and rain-gauges, the former at a cost less than half that involved when obtaining the screens from England. What is described as the outstanding event of the year under review was the setting up of synoptic reporting stations at Hail and Riyadh in Saudi Arabia with the help of King Ibn Saud. A new observatory was also established at Kut al Hai, and a Dines pressure tube anemometer was installed at Rutba at considerable expense. A beginning was made with the preparation for publication of all available climatological data based on observations made in Iraq. The report, therefore, shows that the year was one of progress in spite of the unusual difficulties in the way of advance.

The Ray Society

THE report of the Council of the Ray Society, which has just been circulated, states that, with the consent of the members, the annual general meeting has again not been held, and the present officers and council will continue to act for the current year. The accounts show that the reduction in the amount received from subscriptions has again been less than was anticipated and the sales of the Society's publications have been well maintained. A volume on "The Larvæ of Decapod Crustacea" by Dr. Robert Gurney will shortly be issued to subscribers for 1941. A work on the British Mysidæ (Opossum shrimps) by Prof. W. M. Tattersall is in preparation and is intended to form the issue for 1942. Owing to shortage of materials, the publications will, for the present, be issued in paper covers, but it is hoped later to supply covers for binding uniform with the volumes already published. The Council reminds members that, under present conditions, considerable delay in the publication of the annual volumes cannot be avoided. It is mentioned that at least one author has lost, by enemy action, all the notes and manuscripts prepared for a work to be offered to the Society.

Diseases and War

THE April issue of the *Quarterly Review* contains an interesting article on this subject by Major Frederic Evans, who discusses the problems of an army so far as the maintenance of health is concerned. He classifies the diseases which it is important to prevent in the following nine groups: (1) louse-borne diseases, which consist of typhus fever, trench fever and relapsing fever, (2) mosquito-borne diseases, namely, malaria and yellow fever, (3) diseases caused by sandflies in hot regions, such as sandfly fever, oriental sore and probably kala-azar, (4) excremental diseases, namely, typhoid, paratyphoid, cholera, dysentery and infectious diarrhœa, (5) diseases due to droplet infection, such as cerebro-spinal fever, diphtheria, scarlet fever, measles, smallpox, influenza and pulmonary tuberculosis, (6) venereal diseases and skin diseases, especially scabies, (7) diseases caused by environmental conditions, namely, heat stroke, frostbite and trench foot, and (8) food deficiency diseases, such as scurvy, beriberi and night-blindness. In conclusion, Major Evans emphasizes the importance of the medical officer training his sanitary duty squad as thoroughly as he trains his stretcher bearers and medical orderlies.

The Far East and the War

PROF. P. M. ROXBY's admirable pamphlet on "China" (Oxford Pamphlets on World Affairs, No. 54. London: Oxford University Press. 4*d*. net) provides an excellent introduction, for those who have only now come to realize the importance of China in the War, to an understanding of the place of China in the struggle of the United Nations. Within the compass of thirty pages, he gives a succinct description of the land of China, the impact thereon of the West, and of the Nationalist movement and the progress of reconstruction up to 1931. The latter part of the pamphlet deals with the Japanese seizure of Manchuria and the consequences of the Sino-Japanese war which broke out in 1937. With Sir John Pratt's "Japan and the Modern World" (Oxford Pamphlets on World Affairs, No. 55. 4*d*. net) a penetrating analysis is afforded of the causes which have merged the European and the Far Eastern conflicts into a single war. Sir John Pratt, moreover, in tracing the course of Japanese foreign policy and particularly of Japanese relations with Great Britain, goes to those fundamental differences in national temper and outlook which explain the present hostility of Japan and Great Britain, and indeed raise the question as to the desirability from the start of the Anglo-Japanese Alliance of 1902.

The Indian Science Congress

The following have been elected presidents of the various sections of the 1943 session of the Indian Science Congress, to be held in Lucknow during January 2–8, 1943. The fourteen sections into which the Congress originally divided its work have been regrouped into twelve sections. *Mathematics and Statistics*, Dr. S. C. Dhar, University of Nagpur; *Physics*, Dr. H. J. Bhabha, Indian Institute of Science, Bangalore; *Chemistry*, Dr. S. S. Joshi, Benares Hindu University; *Geology and Geography*, Lieut.-Colonel E. A. Glennie, Survey of India, Dehra Dun; *Botany*, Dr. K. Biswas, Royal Botanical Garden, Sibpur, Calcutta; *Zoology and Entomology*, Dr. B. N. Chopra, Zoological Survey of India, Calcutta; *Anthropology and Archæology*, Dr. N. Chakravarti, Archæological Survey of India, New Delhi; *Medical and Veterinary Sciences*, Dr. F. C. Minett, Imperial Veterinary Research Institute, Mukteswar; *Agricultural Sciences*, Rao Bahadur Y. Ramchandra Rao, Imperial Council of Agricultural Research, New Delhi; *Physiology*, Dr. B. Narayana, P.W. Medical College, Patna; *Psychology and Educational Science*, Dr. B. L. Atreya, Benares Hindu University; *Engineering and Metallurgy*, Prof. K. Aston, Indian Institute of Science, Bangalore.

Night Sky in June

New moon is on June 13d. 21h. 02m. U.T., and full moon on June 28d. 12h. 09m. Lunar conjunctions with the planets occur as follows: Venus on June 10d. 05h., Venus 2° N.; Saturn on June 12d. 08h., Saturn 3° N.; Mars on June 17d. 07h. Mars 4° N. On June 29d. 20h. Venus is in conjunction with Uranus, Venus 1·7° S. Mercury is near the sun during the month and souths at 13h. 03m. and 10h. 39m. at the beginning and end of the month respectively. Venus is a morning star and souths at 9h. 22m. in the middle of the month. Jupiter, in conjunction with the sun on June 25, is too close to the sun to be observed. Saturn is a morning star and souths at the end of the month at 9h. 49m. Only two occultations occur in the month and the brighter of the two stars, 44 Virginis, occulted on June 22d. 22h. 50m., is mag. 5·9. The sun enters the sign of Cancer on June 22d. 01h., the summer solstice, and at this time the nights in the latitude of London are about 7 hours long. If civil twilight is taken into consideration (sun 6° below the horizon) the time of darkness is only 5½ hours. Conditions for seeing the night skies are very much restricted during the month.

Recent Earthquakes

A strong earthquake was reported on May 23 to have occurred in Colombia, South America. The town of Girardot, some sixty miles south-west of Bogota, is stated to have been partly destroyed, and shortly afterwards the island of Gorgona, in Buenaventura Bay, was submerged by a huge wave. This part of South America is particularly liable to experience earthquake shocks. Many of these from 1763 until 1936 have been described by J. Emilio Ramirez, S.J., and one reported by the British Association Seismological Committee in 1907 broke submarine cables off the mouth of the Esmeralda River on January 31, 1906.

The Ecuador earthquake of May 14 was beautifully recorded on the E-W Milne-Shaw seismogram obtained by Rev. J. P. Rowland, S.J., at Stonyhurst College Observatory. The *P* wave was impulsive at 02h. 25m. 50s. U.T. and a full suite of pulses followed. The readings are in agreement with the statements in Nature of May 23, p. 578.

Announcements

Sir Henry H. Dale, president of the Royal Society, will retire from the post of director of the National Institute for Medical Research on September 30. To succeed him the Medical Research Council has appointed Prof. C. R. Harington, who is at present professor of chemical pathology in the University of London and director of the Graham Medical Research Laboratories in University College Hospital Medical School.

Dr. C. G. Darwin, director of the National Physical Laboratory, has been appointed scientific adviser to the Army Council.

The following officers of the Royal Society of South Africa have recently been elected: *President*, Prof. A. Brown; *Hon. Treasurer*, Prof. R. W. James; *Hon. General Secretary*, Dr. A. J. H. Goodwin; *Hon. Editor of Transactions*, Dr. A. L. du Toit; *Hon. Librarian*, Prof. E. Newbery.

The following appointments in the Colonial Service have recently been made: Mr. C. E. J. Biggs (senior agricultural officer, Uganda), deputy director of agriculture, Tanganyika; Mr. A. E. Pound, (inspector of produce, Nigeria), agricultural officer, Kenya.

The population of Peru, according to the last official census, taken in 1940, is 7,023,111 inhabitants (*Bol. Of. San. Panamericana*, January). The female population forms 50·58 per cent, and the male 49·42 per cent. More than half the population, 52·89 per cent, are whites or mulattoes, and 45·86 per cent are Indians, while the Negroes constitute only 0·47 per cent.

In "Belgium and the War" (Oxford Pamphlets on World Affairs, No. 56. 4*d.*), Prof. G. N. Clark describes the economics and politics of Belgium before the German invasion of May 1940, as well as the course of Belgian foreign policy in recent years. The latter part of the pamphlet describes the brief campaign of eighteen days and the reasons for the capitulation of the Belgian army; with, finally, an account of the occupation of Belgium, colonial resistance and of the issues which have made the Belgians carry on the struggle against the Axis Powers.

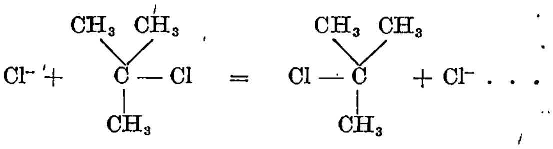
Erratum. In the letter "2-Aminofluorene as Growth Inhibitor for Bacteria and Rats" by F. Bielschowsky and Prof. H. N. Green in Nature of May 9, p. 526, an error in the legend to the graph was overlooked. It should read: "broken line, feeding on 2-acetyl aminofluorenone; crossed line, 2-acetyl aminofluorene".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Calculation of Steric Hindrance

It seems possible to account for the steric effect of non-reacting groups on substitution rates on the lines of the following scheme, illustrated here by the example of the symmetrical substitution of *t*-butyl chloride by chlorine ions :



$$\mathrm{Cl^- + (CH_3)_3C{-}Cl = Cl{-}C(CH_3)_3 + Cl^-} \quad \ldots (1)$$

In the transition state, the four *t*-butyl carbons will be co-planar and the methyl groups will cause least obstruction if arranged in either of the two symmetrical positions one of which is shown in Fig. 1. This is represented in terms of a Fisher model in which the carbon atoms have the usual covalent radii of 0·77 A. and the van der Waals' radii of 1·5 A., while the corresponding values for the hydrogen atoms are 0·32 A. and 1·2 A. respectively. The valencies of the central carbon atom are co-planar, with an angle of 120° between them ; the valencies of the other carbon atoms are at the tetrahedral angle. The position of the chlorine particles in the transition state will be such that the line joining their centres to that of the central carbon will be perpendicular to the plane of the carbon atoms. Further, the carbon chlorine internuclear distances will be equal. From the latest calculation of the transition state, this carbon chlorine distance has been found to be 2·3 A., which is practically equal to the sum of the covalent radius of carbon and the ionic radius of chlorine. These chlorine particles will have a van der Waals' radius of 1·8 A.

While a more detailed consideration, on which we will report elsewhere, shows that the presence of hydrogen atoms on the central carbon (as in the reaction $Cl^- + CH_3Cl$) does not obstruct the approach of the chlorine particles to the required distance, their replacement by methyl groups as in reaction (1) does cause an obstruction. The extent of this obstruction is indicated in Fig. 1, where the shaded sections show the areas over which penetration of the hydrogen atoms by the chlorine particle occurs. The distances between the centres of these obstructing hydrogen atoms and the centre of the chlorine particle can be calculated as 2·43 A., which is 0·57 A. less than the sum of the van der Waals' radii of hydrogen and chlorine. To carry out reaction (1) we have to perform six times this compression as corresponds to the penetration of the chlorine particles into the spheres of the three hydrogen atoms pointing forwards and the three hydrogen atoms pointing backwards in Fig. 1. The corresponding energy of compression has been calculated.

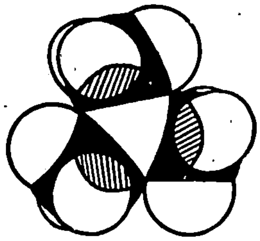


Fig. 1.

The difference between the covalent and van der Waals' radius of an atom is practically the same (0·8 A.) as that between the covalent and negative ion radius. Thus the sum of the covalent radius of carbon and the ionic radius of chlorine will be practically equal to the sum of the van der Waals' radius of carbon and the covalent radius of chlorine. Thus a fair representation of the transition state can be obtained with the Fisher models by setting to each convex side of the central carbon the flat surface of a chlorine atom. (For the central carbon with co-planar valencies a model of the benzene carbon may be used.) This is shown, in the absence of steric hindrance, in Fig. 2, where the chlorine particles *A* and *B* have the covalent radius 0·99 A. and the van der Waals' radius 1·8 A., while the corresponding values for the carbon atom *C* are 0·77 A. and 1·5 A. The distance between the centres *A–C* and *B–C* is the transition state distance 2·3 A.

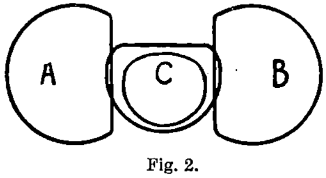


Fig. 2.

By replacing *t*-butyl by *s*-propyl or ethyl, the steric effect is much reduced ; partly by the lessening of the number of points of compression and partly by the possibility of avoiding compression by a bending of the carbon chlorine bonds away from the larger groups. A very considerable steric hindrance can be predicted for the reactions of the neopentyl halides.

A. G. Evans.
M. Polanyi.

The University,
Manchester.
May 7.

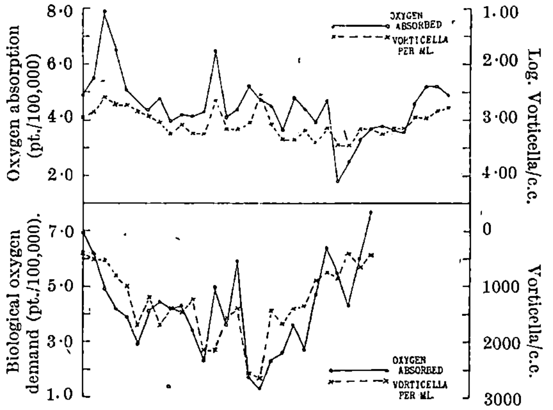
[1] Baughan and Polanyi, *Trans. Faraday Soc.*, 37, 648 (1941).

Vorticella as an Indicator Organism for Activated Sludge

It has been recognized for a number of years that the type of protozoan fauna inhabiting activated sludge in a sewage purification plant of this type affords a useful indication of the condition of the sludge. In 1936, Ardern and Lockett[1] stated that they considered this test as the most useful in determining the activity of sludge and listed the common types associated with varying conditions. More recently, Barritt[2] has further enlarged their general findings. It has been concluded that the presence of ciliates and particularly the peritriches to the exclusion of other classes of Protozoa generally indicates a ripe active sludge. But the scope of the utility of this test has been limited by the fact that they were usually qualitative and therefore complementary only to the quantitative chemical analyses.

Preliminary observations of the activated sludge in the plant at Huddersfield indicated that the ciliates were so limited in variety as to afford a simplified case for determining quantitatively the fluctuations in their numbers and in particular of the Vorticella species in relation to the quality of the effluent produced. This limitation in species is probably due to the high percentage of chemical trade wastes in the sewage and is paralleled by a similar limitation of the macro-organisms in the percolating filters[3].

With the exception of Saturday and Sunday, daily counts of the Vorticella species in the channel liquor were made by dilution and centrifuging so that one tenth of a millilitre was fully examined. Correction was made for the variation of activated sludge per unit of channel liquor since the Vorticellæ are only associated with the sludge particles. The chemical analyses were performed daily by other members of the staff. The three-minute oxygen absorption from acidified potassium permanganate and the biological oxygen demand over five days have been chosen as indicators of the quality of the effluent[4].



From preliminary results obtained it was apparent that the condition of the sludge as judged by the chemical analyses fluctuated somewhat irregularly with a frequency occupying three to four weeks. Two typical periods have been examined statistically, the first extending from September 22 to November 7, 1941, and the second from November 28, 1941, to January 1, 1942. During these periods the Vorticella species varied in abundance from 400 to 5,000 per millilitre. The statistical analysis shows that for both periods the degree of correlation between the oxygen absorption test and the Vorticella abundance is very high and negative (first period, $n = 32, r = -0{\cdot}7703$; second period, $n = 23$, $r = -0{\cdot}6925$). A similar result has been obtained for the relation between biological oxygen demand and Vorticella abundance (first period, $n = 25$, $r = -0{\cdot}7661$; second period, $n = 15, r = -0{\cdot}8380$). These correlation coefficients are of such an order as to place almost beyond dispute the relation between the chemical analyses and the biological assay[5].

The results are of importance (1) because they prove that a definite relation exists between the quality of the effluent and the number of Vorticellæ; this is particularly interesting in the case of the biological oxygen demand test since this analysis takes five days to complete; (2) because they show distinct promise for obtaining a more accurate estimation of the condition of the sludge by utilizing a property of the sludge itself and not its product. Furthermore, a method such as this would eliminate the fluctuations in strength and character of the sewage which renders the estimation of sludge condition by the usual chemical analyses often misleading. Vorticella is a particularly useful organism to employ as an indicator since it is easy to identify even by the non-professional biologist, and also their sessile habit renders them easily and quickly counted. After practice the complete estimation can be performed in thirty minutes.

The observations are being continued to discover whether winter cooling of the sewage has any effect on the relation and also to try to establish definite quantitative evaluations for standardizing the quality of the activated sludge. Any active part which Vorticella and other Protozoa take in the purification of sewage remains to be determined.

I wish to acknowledge the assistance of the members of the staff and also the permission of Dr. H. H. Goldthorpe, manager of the Corporation Sewage Works Department, to publish these results.

T. B. Reynoldson.

Biochemical Laboratory,
Huddersfield Corporation
Sewage Works Department,
Deighton, Huddersfield.
May 4.

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[1] Ardern, A., and Lockett, W. T., *Proc. Inst. Sew. Purif.*, 1 (1936).

[2] Barritt, N. W., *Ann. Appl. Biol.*, **27**, 151 (1940).

[3] Reynoldson, T. B., *Proc. Inst. Sew. Purif.*, 1941 (in the press).

[4] "Methods of Chemical Analysis as applied to Sewage and Sewage Effluents" (H.M. Stationery Office, 1929).

[5] Chambers, E. G., "Statistical Calculation for Beginners" (Cambridge Univ. Press, 1940).

Rheological Properties of Secretions from the Cervix of Pregnant and Non-pregnant Cows

It has already been observed[1] that the flow-curves for bovine cervical secretions tested in an emptying tube viscometer[2] show a curvature which exhibits cyclic variations closely related to changes in the œstrous cycle. We have since found that, considering only the lower part (first 33 per cent) of the flow-curve, in which elastic fore-effect preponderates, curves plotting log $(L^2 - l^2)$ against log t (which are generally remarkably linear[3]) show greater slopes for cows known to be pregnant (three months or more) than for non-pregnant animals. (L is the initial length of the column and l the length after time t.) The slopes (γ) vary from a value of about $0{\cdot}6$ near œstrus to about $1{\cdot}0$ or a little more at some other point in the cycle and reach values sometimes higher than $2{\cdot}0$ in pregnancy.

Of the first fifty cows tested, twenty-seven were at least three months in pregnancy and all these gave γ greater than $1{\cdot}0$ (normally on the means of two tests). Of the remaining twenty-three non-pregnant animals only one maintained a value of γ greater than $1{\cdot}0$ for more than a day or two. This was a cow which had recently calved and which gave a value of γ greater than $1{\cdot}0$ for about a week, but at the first œstrus, γ fell to a normal value.

Samples of mucus have generally not deteriorated when kept at normal room temperature for about two days, but the technique for preparing them for the test, by homogenization and dilution, requires rather careful control. The values of γ are not seriously affected, however, by quite large changes in viscosity produced by dilution with distilled water, though γ tends to fall with such dilution. The arbitrary choice of pressure of extrusion has little effect, though optimum conditions for such factors make for greater accuracy and reproducibility.

We are investigating the changes which take place in γ during the œstrous cycle and in the earlier stages of pregnancy to establish when γ first begins significantly to exceed the maximum value reached during the œstrous cycle, presumably at the luteal phase. Since the high value of γ might depend on the presence of a corpus luteum and since it is of interest to ascertain whether a high value of γ is diagnostic of early pregnancy (there being at present no satisfactory test applicable to bovines) it is necessary to investigate the behaviour of γ during periods of anœstrus due to retention of the corpus luteum, and this we propose to do.

One of us (A.T.C.) is indebted to the Agricultural Research Council for a grant to undertake these experiments.

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A. T. COWIE.
F. M. V. COPPEN.
National Institute for Research in Dairying,
University of Reading.
May 1.

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[1] Scott Blair, G. W., Folley, S. J., Malpress, F. H., and Coppen, F.M.V., *Biochem. J.*, 35, 1039 (1941); NATURE, 147, 453 (1941).

[2] Scott Blair, G. W., *Koll. Z.*, 78, 19 (1937).

[3] The linearity of such curves for non-Newtonian honey was commented on in ref. (2).

Breakdown of Self-Incompatibility by α-Naphthalene Acetamide

SELF-incompatible Petunia, Tagetes, *Trifolium repens* and *Brassica oleracea* have been made self-compatible by spraying the flowering plants with a solution of α-naphthalene acetamide[1]. This new technique has many possibilities to the plant breeder, but without a more complete study of how it works these possibilities cannot be developed properly. Eyster states that "α naphthalene acetamide neutralizes the effects of an ovarian secretion which diffuses into the style and inhibits or greatly retards the growth of pollen tubes". Since there is evidence that incompatibility is due to an immunological reaction between highly specific antigens and antibodies[2,3], it is improbable that α-naphthalene acetamide should be a simple haptene to the incompatibility antibodies of four different genera of plants.

In *Prunus avium*, I find that α-naphthalene acetamide does not increase the rate of incompatible or compatible pollen tube growth, but it does have a profound action on the formation of the abscission layer at the base of the style. Therefore it allows a longer time for the incompatible tubes to reach the ovary. The abscission layer forms two days earlier in untreated and unpollinated or incompatibly pollinated flowers than in flowers treated with α-naphthalene acetamide or pollinated with compatible pollen (see accompanying table). We see, therefore, in this case that the action of the α-naphthalene acetamide is not to 'neutralize' the incompatibility substances but to supply or replace the anti-abscission hormone which is normally produced by compatible pollen tubes or by the ovule immediately after fertilization.

LENGTH OF POLLEN TUBES AFTER FOUR DAYS AND THE NUMBER OF DAYS TO FORM THE ABSCISSION LAYER IN *Prunus avium* VAR. BEDFORD PROLIFIC

Pollen	No treatment		Water		Naphthalene acetamide	
	mm.	days	mm.	days	mm.	days
Crossed *Compatible*	13*	6	13	5	13	7
Selfed *Incompatible*	7·1	4	6·8	3	6·6	6
None	0	4	0	4	0	6

* The 13 mm. incompatible pollinations is an approximation because the tubes at this time were in the ovary.

Since the α-naphthalene acetamide delays abscission for two days, its use may not be confined to removing the bar to self-fertilization but it may decrease inter-specific sterility in plants, especially those with many-seeded fruits. In *Prunus avium*, unlike Petunia, no fruits were obtained after treatment and self-pollination; it is therefore probable that only plants which have a weak incompatibility reaction will be self-fertile after treatment.

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John Innes Horticultural Institution,
Merton, London, S.W.19.
May 2.

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[1] Eyster, W. H., *Science*, 94, 144 (1941).

[2] Sears, E. R., *Genetics*, 22, 130 (1937).

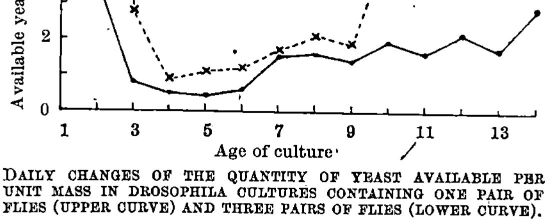
[3] Lewis, D., *Proc. Roy. Soc.*, B. (in the press).

Polygenic Inheritance and the Drosophila Culture

RECENTLY Dr. Mather has directed attention to the importance of the study of polygenic inheritance in relation to practical breeding and to the elaboration of evolutionary theory[1,2]. He has correctly emphasized that failure to study such inheritance lies behind much of biologists' criticism of present-day genetics. However, there is one other important circumstance which, in our opinion, he has not emphasized sufficiently. It is the relation of environment to heredity; the problem of nature and nurture.

In the present context the influence of environment on the expression of heredity has a twofold importance. First, since polygenes "have individual effects which are small compared with non-heritable fluctuations"[2], it follows that their phenotypic expression (or exhibition) is easily modified by environmental changes or differences. Consequently one of the technical difficulties which prevented geneticists from working in this field was the problem of estimating the separate effects of polygenes and environment on the resulting phenotypes. Present statistical methods, as Hogben has pointed out[3], do not always adequately overcome these difficulties. This almost certainly led the "Drosophilists" to concentrate on the study of "unit characters", etc., and to neglect the less easily handled genes or groups of genes the expression of which is easily modified by environment.

Secondly, we have shown that the normal Drosophila culture is not an ideal environment for such studies[4]. As such cultures develop, the *quality* of the yeasts present (the larval food) changes in a more



DAILY CHANGES OF THE QUANTITY OF YEAST AVAILABLE PER UNIT MASS IN DROSOPHILA CULTURES CONTAINING ONE PAIR OF FLIES (UPPER CURVE) AND THREE PAIRS OF FLIES (LOWER CURVE).

or less definite way. This change by itself modifies the phenotypic expression of the variable mutant 'Antennaless'. The *quantity* of yeast available per unit larval mass also changes in these cultures (see graph above). These two major variables will almost certainly affect the exhibition of polygenes. But these environmental changes do not follow the same course in all circumstances[4]. In particular, they are influenced very significantly by the changing numbers of larvæ present in the food medium (see accompanying graph). Hence, in selection experiments care must be taken to ensure that the fertility of females is not altered as selection proceeds. Indeed, Mather's surprising results[1] *may* be explained by such a selection for fertility taking place at the same time as selection for the character studied.

As a corollary to this we may say that the study of polygenic inheritance will be successful only when the technical difficulties outlined above are overcome. As a contribution to their solution we suggest that experiments on selection and inheritance of polygenes in Drosophila be conducted using sterile culture media Such media reduce variability to a considerable degree and permit the handling of constant members of larvæ[4].

C. Gordon.
J. H. Sang.

Department of Natural History,
Marischal College,
Aberdeen.
May 5.

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[1] Mather, K., *J. Genet.*, **41**, 159 (1941).

[2] Mather, K., Nature, **149**, 427 (1942).

[3] Hogben, L., "Nature and Nurture" (London, 1933).

[4] Gordon, C., and Sang, J. H., *Proc. Roy. Soc.*, B, **130**, 151 (1941).

Absorption of Minimal Doses of β-Carotene by Vitamin A-Deficient Rats

Wide differences between the theoretically expected and experimentally obtained potencies of pure vitamin A as compared with β-carotene have led to a considerable amount of speculation[1,2] on the possible manner of conversion of carotene into vitamin A *in vivo*. While there is no direct evidence in support of the postulated unsymmetrical fission of the provitamins, we felt that it might be of interest to study the extent of absorption of β-carotene by rats under the conditions of biological assay.

In the course of these experiments, it was observed that analysis of the fæces of rats maintained on a carotenoid-free diet gives an apparent carotene excretion value of 0·2–0·4 μgm. per rat per day. Examination in a visual spectrophotometer showed this to be due to a non-carotene pigment possessing only a general absorption. By chromatographic adsorption analysis on columns of Brockman's alumina it was possible to separate the carotene from the associated impurity and estimate it quantitatively. The identity of the excreted carotene and the non-carotene nature of the other pigment were confirmed by spectrophotometric data and growth experiments on rats.

Coconut oil content of diet (per cent)	Level of dosage μgm. β-carotene per rat per day	Amount of β-carotene ingested (μgm.)	Apparent carotene excretion (μgm.)	On separation			β-carotene excretion (per cent)
				Non-carotene (μgm. equiv.)	β-carotene found (μgm.)	β-carotene calculated (μgm.)*	
3	1	224·5	114·9	27·3	28·7	31·9	14·0
,,	2	448·9	159·0	40·4	49·8	55·3	12·3
10	1	204·0	117·0	36·0	22·8	25·3	12·6
,,	2	544·0	190·5	59·4	59·5	66·1	12·0

* Chromatographic analysis of known mixtures has shown the caroene recovery to be about 90 per cent, and these values are calculated on this basis.

Some experimental results are summarized in the accompanying table.

The figures presented in this table represent the total amounts for each group of 6–7 rats over an experimental period of 5–6 weeks.

It should be mentioned, however, that in order to get sufficient quantities of the pigments, it was necessary to collect the fæces of each group of rats for 10–14 days and preserve the same in the refrigerator before analysis could be performed. During this interval, a part of the carotene might have undergone destruction and therefore it is probable that the actual excretions were considerably higher than these figures would indicate.

In contrast to the behaviour of carotene, which may be due to its hydrocarbon nature, vitamin A is known to be quantitatively absorbed at far higher levels of intake; at any rate, no excretion could be detected[3,4]. It is therefore suggested that the incomplete absorption of β-carotene might be the major factor responsible for the observed discrepancies; after absorption, perhaps β-carotene is as efficient as vitamin A at the levels of the biological assay.

In a note[5] which reached us during the final stages of this investigation, Wald *et al.* arrive at a similar conclusion based on the results of absorption studies on human subjects at higher levels of intake.

Further work is in progress and full details will be published elsewhere.

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D. N. Hakim.

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March 19.

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[1] Underhill, S. W. F., and Coward, K. H., *Biochem. J.*, **33**, 594 (1939).

[2] Morton, R. A., *Chem. and Ind.*, **59**, 307 (1940).

[3] Wilson, H. E. C., Das Gupta, S. M., and Ahmad, B., *Indian J. Med. Research*, **24**, 807 (1937).

[4] De, N. K., *Ind. J. Med. Research*, **24**, 751 (1937).

[5] Wald, G., Carrol, W. R., and Sciarra, D., *Science*, **94**, 95 (1941).

Chemical Composition of Mitochondria

In 1908 Regaud[1] suggested that mitochondria were "*corps lipoïdes*", and the following year[2] he pointed out the general resemblance between the myelin of nerve fibres and the substance of mitochondria in their reactions to histological fixation and staining. The theory that mitochondria contain a relatively large amount of lipines held its ground for a quarter of a century.

In 1934 Bensley and Hoerr[3] succeeded in actually separating the mitochondria of the liver of the cavy from the rest of the cell, and produced cakes of nearly pure mitochondrial substance in considerable quantity. Roughly a third of this substance is soluble in fat-solvents[4], and it was naturally anticipated that a large proportion of this would consist of lipines. On the addition of acetone, however, a very small precipitate was formed, and it was concluded that only about 4 per cent of the material of mitochondria consists of lipines, the rest of the fatty material being true fat.

Bensley's conclusions differ so widely from those of previous students of the same subject that one looks for a possibility of reconciliation. May it not be that lipines are present in the ether-soluble fraction of mitochondrial substance in considerable amount, but largely resist precipitation by acetone? Ciaccio[5] has especially stressed the solubility of lipines in acetone when other fatty or fat-soluble substances are also present, and Kaufmann and Lehmann[6] have shown that if 2·1 gm. of oleic acid be added to 45 c.c. of acetone covering 2 gm. of lecithin, about half the lecithin goes into solution.

It would be most helpful if those who are expert in the technique of isolating mitochondrial material in quantity from cavy liver could be persuaded to apply tests for lipines to the large fraction of fatty material that is not precipitated by acetone.

John R. Baker.

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Comparative Anatomy,
University Museum,
Oxford.
May 4.

[1] Regaud, C., *C.R. Soc. Biol.*, **65**, 718 (1908).

[2] Regaud, C., *C.R. Acad. Sci.*, **148**, 861 (1909).

[3] Bensley, R. R., and Hoerr, N. L., *Anat. Rec.*, **60**, 449 (1934).

[4] Bensley, R. R., *Anat. Rec.*, **69**, 341 (1937).

[5] Ciacco, C., see Lison, L., "Histochimie animale" (Paris, 193[illegible]), 206–208.

[6] Kaufmann, C., and Lehmann, E., *Centralbl. allg. Path.*, **37**, 145 (1926).

Reversible Quenching by Oxygen of the Fluorescence of Polycyclic Hydrocarbons

We regret that, as Dr. E. J. Bowen has pointed out[1], the important paper of Bowen and Williams[2] on the photo-oxidation of aromatic hydrocarbons has indeed escaped our notice, but we hope that our previous communication[3] has served a useful purpose in directing attention to the occurrence of the phenomenon in the visible fluorescence of cancerogenic hydrocarbons where it has not hitherto been described. This reaction is not only of practical importance for analytical fluorescence measurements, but also of theoretical interest as a possible initial stage in the metabolic oxidation of these substances.

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North of England Council of the
British Empire Cancer Campaign,
Royal Victoria Infirmary.

Joseph Weiss.

Department of Chemistry,
King's College,
University of Durham,
Newcastle-upon-Tyne.
May 12.

[1] Bowen, E. J., Nature, **149**, 528 (1942).

[2] Bowen, E. J., and Williams, A. H., *Trans. Faraday Soc.*, **35**, 755 (1939).

[3] Weil-Malherbe, H., and Weiss, J., Nature, **149**, 471 (1942).

Determination of Water in Soils

The usual method for determination of water in soils (that is, heating to 110° C.) is almost always unsatisfactory owing to decomposition and slow oxidation of organic matter; moreover the determination takes a long time to complete.

A series of experiments have therefore been carried out using the method described by Lowndes[1], using a Dean and Stark's tube. The sample is thus distilled under xylene or toluene (b.p. 137° and 110·7°), the water which comes over being weighed or its volume read off. The determination is completed in 2–4 hours and losses due to oxidation are avoided.

It will be seen that the results for a well-cultivated loamy garden soil are consistent among themselves and that the results with toluene agree with those obtained with xylene. With samples of chalk it was possible to apply a check by oven-drying, showing that the method is working satisfactorily.

Results with a dark clay loam

Sample	Appt. no.	Liquid used	Water (% dry wt.)	Average %
IV	3	Xylene	8·5	8·3
	6	,,	8·3	
	5	,,	8·0	
VIII	3	Xylene	21·2	21·2 (with xylene)
	6	,,	21·2	
	8	Toluene	21·7	21·8 (with toluene)
	4	,,	21·9	
I, *a*	9	Xylene	33·5	33·6
	5	,,	33·8	
	3	,,	33·6	
V	3	Xylene	56·3	55·8 (with xylene)
	6	,,	55·3	
	8	Toluene	56·4	55·9 (with toluene)
	5	,,	55·3	

Results with chalk (using xylene)

Appt. no.	Water (% dry wt.)	% water (by oven drying at 110°)
1	23·8	24·8
2	23·5	24·4
2	22·2	22·4
2	13·2	13·5
3	7·2	7·0

These results have not been corrected for the small amount of water left on the walls of the apparatus, which amounts to about 0·1 gm. but varies with the construction of the tube.

Further work is in progress on the application of this method to the investigation of soil moisture, but as there seems to be no doubt of its suitability and obvious advantages for most purposes, it was felt that the above preliminary results were worth putting on record.

G. H. Locket.
W. H. Barrett.

The Science Schools,
Harrow School.
May 5.

[1] Nature, **148**, 594 (1941).

Molecular Sodium Hydride in Interstellar Space

In a recent article[1] describing results obtained with the coudé spectrograph of the Mount Wilson Observatory, W. S. Adams gives some details of the identification of a number of interstellar lines with absorption lines of various molecules in their lowest possible energy states. Among others he mentions a line at λ 3934·3 provisionally assigned to NaH by McKellar[2].

Now the hydrides of the alkali metals are characterized by spectra containing band systems of rather unusual intensity distribution. For the molecule RbH an approximate calculation of the relative intensities of the bands of the system in emission has been made by Gaydon and Pearse[3]. The results may be applied to absorption by molecules in the lowest state by assuming an initial distribution of all the molecules in the level of the lower electronic state for which $v'' = 0$, instead of a Maxwell distribution among the vibrational levels of the upper electronic state. The factor ν^4 is also changed to ν for absorption, but this is relatively unimportant in its effect on the results. This has been done in the course of an investigation of the spectrum of the NaH molecule by R. C. Pankhurst with the results shown in the accompanying table.

v',v''	λ	I_0	I_c
0,0	—	—	0
1,0	—	—	0
2,0	—	—	0
3,0	—	—	1
4,0	4230·6	0	3
5,0	4169·0	2	7
6,0	4108·4	5	16
7,0	4049·0	7	27
8,0	3990·9	9	42
9,0	3934·3	10	50
10,0	3879·4	10	50
11,0	3826·0	9	—
12,0	3774·3	9	—
13,0	3724·5	9	—

Here v',v'' are the vibrational quantum numbers of the upper and lower levels, λ is the wave-length given by Hori[4] for the R (0) line of the band as observed in absorption, I_0 is his corresponding band intensity, while I_c is the value of the intensity obtained by calculation. It will be noticed that the experimental and calculated values agree on the general course of the intensity from vanishingly small values near the origin of the system rising steadily to a flat maximum in the (v', 0) progression. Without laying too much stress on the actual numerical values, which are based on an arbitrary scale of 50 for the maximum in the calculated relative intensities, I_c, and are eye-estimates on a scale of 10 for the maximum in I_0, it may be noted in favour of the assignment that the transition observed, namely (9,0), is in the region of the maximum, but since in this region the intensities of neighbouring bands are so nearly the same, it would seem that they also should be obtained. If this could be done the probability of the identification being correct would be greatly strengthened.

R. C. Pankhurst.
R. W. B. Pearse.

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May 6.

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[1] Adams, W. S., *Astrophys. J.*, **93**, 11 (1941).

[2] McKellar, A., *Pub. Ast. Soc. Pac.*, **52**, 187 (1940).

[3] Gaydon, A. G., and Pearse, R. W. B., *Proc. Roy. Soc.*, A, **173**, 37 (1939).

[4] Hori, T., *Z. Phys.*, **62**, 352 (1930).

Reflexion from Paper

I have observed a curious optical effect which I have not seen described anywhere. If an open book is illuminated fairly strongly from one side, for example, from over one shoulder, the general colour of the white paper is different for the two eyes when one or the other is closed. The effect has been tried with several subjects with the same result. When the light comes over the left shoulder and the left eye is open the pages have a bluish tinge; when the right eye is open and the left closed the tinge is reddish. If the light comes over the right shoulder the above effects are reversed. If the light is centrally placed above and behind the head there is no difference.

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I think the effect Mr. Burke describes is due to selective specular reflexion from the paper. Many near-white papers are slightly more glossy in red light than they are in blue; that is, the specularly reflected light contains relatively more red and less blue than does the incident light. If the incident light comes over the left shoulder, the right eye will be rather nearer the angle of specular reflexion than the left, consequently the light reaching the right eye will be a little richer in red.

The effect can be observed in more pronounced form with many glossy coated ('art') papers, if they are illuminated and viewed at an angle of about 70° to the normal: the diffuse image of the light source appears distinctly orange or reddish compared with the source itself.

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History of the British Thermal Unit

The date of the phrase "British thermal unit" can be pushed back by fifteen years; it occurs in W. J. M. Rankine, "Manual of the Steam Engine" (1859), p. 300; but here, as in the 1875 quotation given by Dr. Powell[1], it is a descriptive phrase and not a technical term; Rankine is in fact contrasting the British thermal unit and the French thermal unit.

It occurs, however, as a technical term in 1889 in De V. Wood, "Thermodynamics", 3rd ed. (New York), p. 3 ("The British Thermal Unit (B.T.U.)"). (I have not been able to consult earlier editions of this book.) H. Evers, "Steam" (1889), p. 4, speaks simply of "A Unit of Heat"; M. H. Wright, "Heat" (1893), p. 79, says: "In England the unit of heat or thermal unit is . . ."; W. S. Hutton, "Steam-boiler Construction" (1891), p. 4, speaks of "The British thermal unit".

It would seem likely that it was in the United States that it was first found necessary to incorporate the word British in the name of the unit, and that the phrase then recrossed the Atlantic as a technical term, and reached British physicists by way of British engineers.

G. Woledge.

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May 13.

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[1] Nature, May 9, p. 525.

POST-WAR PLANNING IN RADIO TELECOMMUNICATION

THE meeting of the Wireless Section of the Institution of Electrical Engineers on May 6 was devoted to a discussion on "Post-War Planning in Radio Telecommunication", which was opened by Sir Stanley Angwin, engineer-in-chief of the Post Office, and a member of the committee of the Institution studying the possibilities of post-war planning in electrical engineering in general. While it is true to remark that all possible efforts on the part of radio engineers and physicists should be devoted to ensuring that the present conflict will lead to a victorious issue for the Allies, it is equally wise to observe that those with experience and responsibility should divert a little of their time to the consideration of the problems which will most certainly arise at the termination of the War.

Sir Stanley's opening remarks were concerned chiefly with the probable developments in post-war telecommunications—line, cable and radio—for conducting the normal peace-time business of the world, while, in addition, he outlined the probable future of broadcasting, television and the application of radio technique to various spheres, in particular, navigation. It is already clear that radio telegraphy and telephony on one hand, and the submarine cable and land line on the other, are complementary services, and their respective applications are decided by matters of distance and geography, as well as by technical considerations. In both this field and the similarly extensive field of broadcasting, it will be necessary after the War to resume consideration, on a world-wide basis, of the equitable division of radio frequency channels among the various services requiring them. The putting into effect of the most recent plan for the distribution of the frequencies or wave-lengths of European broadcasting stations, was interrupted by the outbreak of war; but in any event a considerable revision of this plan will probably be necessary on a return to normal conditions.

The design and development of broadcasting transmitters and receivers will need to be reviewed in the light of advances of technique and knowledge, and a certain amount of standardization may become necessary. In the field of television the technique of the service, and in particular the mode of presentation of the picture in the receiver, must be reviewed in some detail. With the view of relieving the radio channels of all unnecessary traffic, it is likely that more serious attention will be required to the scope offered by the use of land-lines for the distribution and relaying of broadcasting and television programmes. Finally, Sir Stanley Angwin referred to the problems which will have to be faced in connexion with the return to industry of staffs at present in the Services or in Government establishments. The radio and telecommunications industry will also have to deal with the technical matters connected with the reopening of overseas markets, if we are to take a proper position in world trade.

In continuation of the discussion, Dr. R. L. Smith-Rose referred to various problems likely to be encountered in connexion with fundamental research and development, the technical standardization of equipment and components, the re-allocation of personnel at present engaged on radio work, to the recognition of the radio-physicist as well as the properly qualified radio electrical engineer, and finally to the matter of post-war publication.

In the field of research, it will be found that whi the radio wave spectrum has been considerabl extended during the War, much of the ground w have been hurriedly and only very superficial explored, and there will remain a good deal of wor in the examination and consolidation of principl and technique before it will be possible to make th best use of the frequency bands then available. will probably be found necessary to extend the rang of research, both fundamental and applied, in orde to find room and allocations for the greatly increase number of services which will be awaiting applic tion. In connexion with this matter, it will be nece sary to give renewed attention to the technic merits of wired broadcasting, single side-ban transmission, and the possibilities of the very sho wave bands for relays and short-distance radio link With the extended use of the very short wave-length the subject of interference and its suppression will b brought into the limelight again, particularly a many of the purposes to which radio technique ha been applied during the War are not conducive t freedom from interference.

If the radio industry is to develop satisfactorily o an extended basis at the end of hostilities, it i likely that a considerable amount of standardizatio of valves, components and equipment will be neces sary, while there will be ample work for those whos duties include the preparation of specifications an test schedules. In the latter connexion, it will b desirable at a very early stage to lay down a state ment or code of safety precautions to be followed i dealing with the very high voltages found nowaday in radio receivers and cathode ray tube apparatus During present conditions much of this gear ha been produced hurriedly, and without the precau tions which have hitherto been considered essentia by the fully trained and experienced electrica engineer.

With regard to the question of personnel an staffs, Dr. Smith-Rose believes that while many a present attracted to radio work in the variou Services will return to their different peace-tim occupations, many—especially the younger member —will attempt to stay to make a career in som branch of the radio industry. This influx of per sonnel will present a problem for the Institution o Electrical Engineers itself to deal with, for whil many of these radio workers will possess adequat academic qualifications in science, and some practica experience, they can scarcely be classed as full qualified electrical engineers according to the Insti tution's standards. Furthermore, many of thos who return to their normal occupations in science art or business are likely to wish to retain an interes in radio as a hobby, and the Post Office authoritie might well be thinking over their future attitud towards the post-war radio amateur. The universitie will also have to recognize a continuous need fo properly educated recruits to a stable and growin profession, and it will be clearly desirable that well-arranged graduate course in communicatio engineering should rank on an equal footing in th future with electrical engineering.

Another matter that may well receive consideration in advance by institutions and societies, as wel as by the technical periodical Press, concerns th method of handling the vast volume of publication that will suddenly become available when the existing barriers of secrecy are removed. Indeed the quantity of radio literature that will pour out under post-war conditions may demand a considerable extension in our present methods of systematic arrangement, abstracting and indexing. In this connexion, two useful suggestions were made later in the discussion, by Mr. D. A. Bell and Dr. L. E. C. Hughes. The first was to the effect that it would prove very desirable to institute some kind of critical reports of progress in the various phases of radio technique, perhaps on the lines of the series of annual reports already issued by the Physical Society; while the second directed attention to the desirability, if not of the necessity, of using micro-film technique for the recording of published papers.

Messrs. V. Z. de Ferranti and C. E. Strong outlined the difficulties which are likely to confront a radio industry suddenly called upon to make a change-over from the carrying out of war contracts to Service specifications, to the re-establishment of a peace-time industry on a stable basis. It is clear that the present radio industry has not been planned on a sufficiently large scale, and it was suggested that this experience should be borne in mind in the future. At the termination of the present War, it is probable that the whole radio industry will require an interval in its production programme while the design and development of the new peace-time equipment is carried out. Some considerable foresight will be needed here to retain groups of staff and workers intact over a comparatively slack period before the industrial machine gets into its new stride.

Mr. J. A. Smale said that he anticipated many developments in the field of point-to-point radio telegraphic communications, including the use of printing telegraphs and coded messages. To a large extent the standards of transmission have been relaxed during the War, and it will be necessary to recover these if all the available channels are to be used in the most efficient manner. Mr. A. D. Blumlein expressed the somewhat comforting opinion that the methods of distributing television programmes used in 1939 were about right, and, apart from minor improvements, would need only slight revision to resume broadcast operation.

The probable directions in which the broadcast receiver industry is likely to resume activities were examined in some detail by Dr. R. C. G. Williams, who believes there is the possibility of some Government control of the industry as an outcome of a reconsideration of the political side of broadcasting. Both he and other speakers envisage the possibility of the use of an improved projection type of cathode ray tube for obtaining better picture reproduction in domestic receiving equipment.

After further contributions by other speakers, the discussion was brought to a close by Mr. H. Bishop, chairman of the Wireless Section of the Institution. It is desirable, he said, to plan a bold policy of expansion in the whole field of telecommunications, and this will of necessity involve dealing on a national basis with all the problems which have been brought forward, and particularly those of staff, education, and research and development. He referred to the difference in standards in television in the United States and in Great Britain, and agreed that our own system could quickly be ready for the resumption of a satisfactory public service. He also referred to the desirability of encouraging increased co-ordination in the field of post-war research, and expressed the hope that many secret devices developed under war conditions will be released for a peace-time application in due course for commercial purposes.

THE FUTURE OF TECHNICAL EDUCATION[*]

By H. J. CULL

IN common with all sections of the community, technical teachers find the progress of the War marked by increasing demands upon them. Apart from special courses, the average experience appears to be of a large increase in the part-time day classes of the colleges and the maintenance of evening or the substituted week-end classes at something approaching their normal level. To cater for these with, in many cases, depleted staffs has called for sacrifices of many of our cherished ideas as to conditions of service—changes in hours of duty per week, sizes of classes and suitability of accommodation for classes—which will demand the watchful care of the Association if they are to be regarded as temporary expedients and not precedents.

Education and the Future

Prominent in our thoughts in spite of many preoccupations is the discussion which has been in progress during the year on educational post-war reconstruction. Inspired in the first place by an official invitation by the Board of Education, the executive of the Association of Teachers in Technical Institutions, as well as similar groups within other major educational associations, has given consideration to this matter. Official pronouncements by succeeding presidents of the Board of Education, as well as provisions already on the statute book awaiting the announcement of "appointed dates" and also the war-time developments of activities among young people, make certain steps in reconstruction almost self-evident. It would appear, for example, that after the age of eleven plus, all schools should be secondary in character, equal in status, and administered by one department of the Board of Education. The main interest here of the Association is to secure the continuance as individual entities of those schools which have so fully justified themselves during recent years, namely, the junior technical schools. These schools, giving a broad general education; with a scientific approach to an industry as a whole; working in close association with the industry of the district; and provided with the equipment and the qualified staff to give the industrial bias, have achieved a success which cannot be questioned. The one handicap which has always been present and has had to be overcome has been the suggestion of inferiority due to the later age of entry when compared with other types of schools. If this be removed by the general reconstruction, we have no fear that the schools will produce youths who will be other than a credit to themselves and any society in which they are partners. Pioneers in this type of school are convinced of their value from the point of view of the student—not alone of the industry which they join. The realistic approach to the studies means much to certain types of young people, and that is the real justification for wanting to preserve the schools and extend the experiment.

We are watching a development of adolescent education in two distinct directions at the moment. Firms are releasing for part-time day education employees in larger numbers than ever before.

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[*] Substance of the presidential address delivered before the Association of Teachers in Technical Institutions on May 23.

Tribute must be paid to those firms who have thus met the difficulties of the youths in continuing their technical studies. It is believed that this war-time experience will persuade many firms of the value of this education, to their employees and to themselves, and that it will grow on a voluntary basis from year to year. Nevertheless we feel that part-time release should be made obligatory from the statutory age for full-time education, up to the age of eighteen. Much of such part-time work would be vocational in character and would be centred around the technical college.

Youth service is being officially sponsored in Great Britain for the first time. If part-time release for educational work is part of the reconstruction scheme, there must grow up in most districts a new type of school, already tried in a few areas, namely, the day continuation schools. This new youth service would in many cases seem to fuse with the work of the day continuation school. At the moment, the youth activity is bound to be war-biased, but one can hope that the aim of the combined day continuation school and youth activity will be to develop that complete personality inherent in us all—involving physical well-being; a developed mind able to appreciate and express; and a spiritual entity able to appreciate beauty in many directions and to take part in its perpetuation. So we find a further problem facing us on the technical side. Our organization of the vocational needs must be such as will not debar the youth of our colleges from a goodly share in physical and humanitarian activities.

Full-time Technical Education

In general reconstruction, too, the technical teachers would expect to realize some of those projects for which they have pressed for many years. For example, technical colleges have a contribution to make to a developing society by a more widely developed system of full-time courses. These might be attended by students coming direct from other types of schools, but perhaps more frequently by suitable partly trained students securing release from industry for a period to complete a course of training. Many pronouncements are made in these days that university students benefit greatly if they preface their university studies by some period in employment. This would probably be even more true of full-time work in technical colleges. Associated with this is the whole question of scholarships for these senior students in the colleges, which we have claimed as deserving of official attention for some years now. Regional co-ordination of the senior colleges is a further point which will need consideration in the complete scheme.

As we plan now for a post-war community we are largely groping in the dark. We do not know much of the conditions in which we shall find ourselves. For this reason we should refrain from being closely fettered by decisions. We believe victory will bring us a greater measure of freedom to develop as individuals and as members of an international commonwealth. The great aim should be that we as teachers shall be ready to seize our opportunities on behalf of the youth of the country and bring to them better fruition than ever before. Led by a president of the Board of Education of full cabinet rank and able to make demands as a right to a full share of the country's resources for education, we should be alive to every possibility of advance along the lines we have set. Perfect buildings, staffs large enough and well enough trained for the perfect schools, equipment worthy of the standard set will probably be acquired only slowly. But war-time training of youths has produced results which have not reflected the difficulties under which it has been carried out. Under peace conditions we need not wait for the perfect surroundings before starting to train youth to make the most of their personalities.

Building and Agriculture

Turning to more immediate problems, we find evidence of much that demands careful thought. The Board of Education has indicated the need for the development of junior technical schools for the building industry. No departments of our colleges have suffered more in the depletion of their work during war-time than those of building. Yet imagination does not need much scope to see the immediate importance of this industry after the War. The Association welcomes the suggested encouragement of these schools. It visualizes them as being schools of the type mentioned previously, presenting an approach-view of the industry as a whole. Such a training would lead to a definite apprenticeship and form part of the apprenticeship training. There is time to plan this as a complete scheme and a permanent one, and it should not develop as a rough preparation for immediate post-war needs only. The industry and the senior college building departments must be important partners in the plan.

Another aspect of technical education has been recently considered: that affecting agriculture. Though of course provided with its own unique difficulties, the needs of this industry for a scientific background to its studies is as great as any other.

SCIENCE AND THE WAR EFFORT

A "SCIENCE for Victory" Conference, organized by the Southern Area Committee of the Association of Scientific Workers, was held at University College, Southampton, on May 17. The meeting attracted scientific and technical workers from a wide area of southern England. Mr. Alexander Orba (instructor in radio at University College) presided at the afternoon session, and opened the Conference; he said that this was the first representative gathering of scientific and technical workers to be held in the Southampton area, to discuss the organization of their affairs and represented an important step forward in the part to be played by scientific men in the life of such an industrial area.

The opening speaker was Mr. H. W. Steele-Bodger, past president of the National Veterinary Medical Association, who spoke of the part veterinary science can play in the war effort by increasing the production of such foodstuffs as meat and milk. He emphasized that agriculture is really the basic and fundamental science and must be kept alive and flourishing if the people are to be fed. A Survey Committee of the National Veterinary Medical Association produced a comprehensive scheme for the control of diseases of livestock, and after years of patient effort had persuaded the Ministry of Agriculture to adopt it. As a result, he was confident that milk production would be very materially increased by the winter of 1943. In general, however, such progress is hampered by ignorance of veterinary science, even in the highset quarters, and by conservatism and lack of co-operation among the farming community.

Mr. C. F. Carr, editor of the *Southern Daily Echo*, gave a short talk on "Science and the Press", in which he expressed the view that unless the newspaper industry is prepared to encourage research directed towards speeding up and improving its own productive processes, it will soon be completely out-done by broadcasting. He hoped they would get down to this and also that the Press might be to a much greater extent the vehicle for disseminating scientific knowledge to the public.

Dr. Harry Barron, head of the Plastics Department of Pirelli-General Cable Works Ltd., spoke on the subject of synthetic rubber. He explained how vital rubber is, not only to the war machine, but also to industry as a whole; no longer can oil and steel be regarded as the only criteria of a nation's ability to make war. Since the loss of natural rubber supplies in the Far East, Great Britain may have difficulty in lasting out this year on existing stocks. The U.S.S.R. and Germany both built synthetic rubber industries years ago; the United States started some time ago to build up such an industry; but in Great Britain, owing to the continual obstruction of powerful vested interests, no start has been made even now. Not even the essential raw material—carbide—is available, as we have no carbide industry. The American industry will not be in a position for a year or two to supply us with quantities large enough; 50,000 tons a year has been glibly talked about, but the total production this year is unlikely to exceed 40,000 tons. We need to be most economical in the use of rubber, and to save every scrap for reclamation. Dr. Barron thought we should set about solving the problem immediately by building quite small pilot plants, in order to gain experience in the processes and to train the technicians needed.

The evening session was presided over by Dr. Barron, who read out a letter from the Association of Scientific Workers to branches in the radio and electrical industries, asking for information about the misuse, wastage or under-employment of technical resources, about which a Committee of the War Cabinet has asked for investigations to be made.

The first speaker was Mr. C. E. G. Bailey, of the Mullard Radio Valve Co. He spoke on "Radio Research and the War", and began by describing the peace-time condition of the industry, in which, except for television development carried on almost exclusively by the large firms, technicians were mostly engaged in thinking out sales points, such as fancy tuning scales and push-button circuits. Little real research was done. At the same time, the few Government establishments maintained were hampered by inter-Services rivalry and by the difficulty of obtaining the best scientific brains, owing to humdrum conditions of work. The crisis of war has made plain the need—previously seen only vaguely—for the industry to change from the spirit of commercial competition to one of technical co-operation if real progress is to be made. Even at this eleventh hour, co-operation between the Services, between firms and between Services and firms, and the proper allocation of jobs, are only just being organized on a reasonable scale.

Turning to the subject of post-war reconstruction, Mr. Bailey said that this is a two-edged term. It is usually interpreted by employers as meaning that they must carve a niche for themselves in the post-war markets, so as to "avoid dismissing their employees". However, we must not employ technicians now in designing broadcast receivers on the old competitive lines, when their services are so vitally needed for war work.

In the subsequent discussion, one speaker suggested that the Association of Scientific Workers should be ready to put forward a general plan for the post-war industry, which would indicate future lines of research and ensure that ample work is available.

The final contribution was by Mr. Alexandra Orba, of University College, Southampton, on "Technical Education". He outlined a plan for education designed to produce the technicians required for immediate war-time needs as rapidly and efficiently as possible, and at the same time to lay the foundation for a more satisfactory educational system after the War. We shall then have a larger number of people with technical knowledge than ever before, and we must take full advantage of this to build up a different attitude towards science and its cultural value. We must see that the vocational training given is related to the needs of society at the time and the estimated future needs; we must train staffs for all grades of work in industry, for executive and administrative posts as well as technical ones.

There was considerable discussion following this address, and a resolution "That the Board of Education be urged to give consideration to the need for teaching all school children something of the organization and processes of modern industry" was carried.

The Conference served a useful purpose in focusing attention in the area on the need for the application of scientific effort both immediately and for the future, and a number of resolutions arising out of the papers which had been discussed were passed.

LONDON SCIENTIFIC FILM SOCIETY

THE London Scientific Film Society gave a demonstration of films on May 16 at the Imperial Institute cinema. Dr. Julian Huxley introduced the film "Galapagos" and led a discussion on it afterwards. The film was made by the Dartington Hall Film Unit under the direction of Mr. William Hunter and Mr. David Lack and was photographed by Mr. Richard Leacock. It illustrates the comparatively free adaptive evolution of new types, in absence of competition, from original single colonizations on a group of oceanic islands. The extent of the differences from the mainland forms depends on the time that elapses since the colonization. In such cases, where the pressure of natural selection is light, the animals are not as well equipped to fill their environmental niches as are mainland forms. For example, there is a member of the gull tribe, the close ancestors of which are water birds, which nests in the trees although it still retains webbed feet; and the finches have evolved a range of species to exploit the available food supplies, although the shape of their beak, unlike those of most mainland birds, does not always give a precise indication of the food habits of the bird.

Dr. Huxley also pointed out that there is a tendency to gigantism in absence of competitors, as shown on the Galapagos by the giant tortoises and iguanas, and that animals can extend to unusual habitats, as shown here by the unique sea lizard and the red land crabs.

The film is well photographed, but it is to be regretted that there are no pictures of the mainland birds from which the island forms evolved and that the captions are scarcely sufficient to explain the purpose of the film. It was pointed out that the absence of sufficient funds explained some of the unavoidable deficiencies of the film and why it was only available on 16 mm. silent film.

In the discussion which followed it was asked whether any steps are being taken to preserve such valuable films, which show animals that are fast becoming extinct. It was explained that the National Film Library of the British Film Institute has as one of its aims the preservation of films which illustrate the development of the cinema and of social history, but that it does not collect films specially for their scientific or technical content. The Scientific Films Committee of the Association of Scientific Workers (on whose recommendations the programmes of the London Scientific Film Society are largely made) has recently made a plea to the National Film Library for the preservation of scientific films and has made out a list of those that it considers should be obtained now. "Galapagos" is one of them.

Other films shown by the Society at this meeting were: "Propeller Making", "This is Colour" (an Imperial Chemical Industries film in Technicolor about dyes), "A Few Ounces a Day" and an excellent film epic recently arrived from the United States of the building of the Boulder Dam in Colorado.

FORTHCOMING EVENTS

Saturday, May 30

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "Problems of Collective Feeding in War-time".

Monday, June 1

Royal Geographical Society (at Kensington Gore, London, S.W.7), at 5 p.m.—Geographical Films.

Friday, June 5

Geologists' Association (in the Rooms of the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Frank Debenham: "Shelly Drift in the Antarctic".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Head of Department of the Junior Technical School for Building in the Bournemouth Municipal College—The Director of Education, Town Hall, Bournemouth (June 4).

Lectureship in Clinical Pathology—The Secretary, University College, Cork (June 6).

University Chair of Biochemistry tenable at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (June 8).

Lecturer in Pharmaceutical Subjects—The Principal, Leicester College of Technology and Commerce, The Newarke, Leicester (June 13).

Assistant Mistress to teach Biology and Subsidiary Chemistry—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (June 13).

Chemist to assist in an investigation on the production of organic fertilisers—Prof. H. A. D. Neville, The University, Reading.

Mechanical Engineer for Mine on the Gold Coast engaged on production of essential war material—The Secretary, Ministry of Labour and National Service, Central Register (Ref. O.M.C. 968), Public Trustee Office, Sardinia Street, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Society for the Protection of Birds. Fifty-first Annual Report January 1st to December 31st, 1941; with Proceedings of Annual Meeting, 1942. Pp. 40. (London: Royal Society for the Protection of Birds.) [45

Annual Report of the Oundle School Natural History Society. Pp. 24. (Oundle: Oundle School.) [45

Reports on Progress in Physics. Vol. 8 (1941). General Editor W. B. Mann. Pp. iv+372. (London: Physical Society.) 25*s.* net. [55

Sheffield City Libraries. Research Bulletin No. 6: Machining of Metals. Pp. 46. (Sheffield: Central Library.) [55

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 24: The Limestone Coal Group of the Glasgow District. By Dr. M. Macgregor; with Note on Palæontology of Principal Mussel-bands, by Dr. J. Weir and Dr. D. Leitch. Pp. 22. (London: Geological Survey and Museum.) 1*s.* 1*d.* [55

Proceedings of the Royal Society of Edinburgh, Section B (Biology) Vol. 61, Part 2, No. 17: A Study of the Cytoplasmic Inclusions durin the Spermatogenesis of the Mouse. By Dr. R. A. R. Gresson. Pp 197–210 (2 plates). 1*s.* 3*d.* Vol. 61, Part 2, No. 18: Variation i *Gryphæa incurva* (Sow.) from the Lower Lias of Loch Aline, Argyll By Rhona M. Maclennan and Dr. A. E. Trueman. Pp. 211–232 1*s.* 9*d.* (Edinburgh and London: Oliver and Boyd.) [11

Geological Survey of Great Britain: Scotland. Wartime Pamphle No. 13: Limestones of Scotland, Area 3: East-Central Scotland By D. Haldane and Dr. J. B. Simpson; with Analyses by Dr. A Muir and H. G. M. Hardie. Pp. 30. (London: Geological Surve and Museum.) 1*s.* 5*d.* [135

Annual Report for 1941 of the Research Departments of th College of the Pharmaceutical Society. Pp. 36. (London: Pharmaceutical Society.) [145

Burton-on-Trent Natural History and Archæological Society. Loca Records for 1941. Pp. 25. (Burton-on-Trent: Natural History an Archæological Society.) 1*s.* [145

Other Countries

University of Illinois: Engineering Experiment Station. Circula Series No. 42: Papers presented at the Twenty-eighth Annual Conference on Highway Engineering held at the University of Illinois March 5–7, 1941. Pp. 91. 50 cents. Bulletin Series No. 333: Th Suitability of Stabilized Soil for Building Construction. By Edwin L Hansen. Pp. 40. 45 cents. Bulletin Series No. 329: A Study of th Collapsing Pressure of Thin-Walled Cylinders. By Rolland Georg Sturm. Pp. 80. 80 cents. (Urbana, Ill.: University of Illinois.) [11

Bernice P. Bishop Museum. Bulletin 170: Land Utilization i American Samoa. By John Wesley Coulter. Pp. 48+2 plates. Bulletin 171: Report of the Director for 1940. By Peter H. Buck (T Rangi Hiroa). Pp. 33. (Honolulu: Bernice P. Bishop Museum.) [11

U.S. Department of Agriculture. Farmers' Bulletin No. 1885 Treatment of White Pines infected with Blister Rust. By J. F. Marti and G. F. Gravatt. Pp. ii+28. 10 cents. Miscellaneous Publicatio No. 468: Raspberry Fruitworms and related Species. By H. S Barber. Pp. 32. 10 cents. Technical Bulletin No. 801: Insecticida Efficiency of some Oils of Plant Origin. By A. W. Cressman an Lynn H. Dawsey. Pp. 16. 5 cents. (Washington, D.C.: Governmen Printing Office.) [11

Occasional Papers of the Bernice P. Bishop Museum. Vol. 16, No 9: Encyrtidæ of the Marquesas and Society Islands (Hymenoptera Chalcidoidea). By P. H. Timberlake. Pp. 215–230. Vol. 16, No. 10 Psammocharidæ from the Solomon Islands, Prince of Wales Island and New Caledonia. By Nathan Banks. Vol. 16, No. 11: The Hippoboscidæ of Oceania (Diptera). By Joseph C. Bequaert. Pp. 247-292. Vol. 16, No. 12: Viability of Coconut Seeds after Floating i the Sea. By Charles Howard Edmondson. Pp. 293–304. Vol. 16 No. 13: The Isopod Crustacea of the Hawaiian Islands, 2: Asellota By Milton A. Miller. Pp. 305–320. Vol. 16, No. 15: Miscellaneou Notes on Hawaiian Plants, 2. By F. Raymond Fosberg. Pp. 337-348. Vol. 16, No. 16: The Genus Araucaricola in Fiji (Coleoptera Tenebrionidæ). By Elwood C. Zimmerman. Pp. 349–356. (Honolulu Bernice P. Bishop Museum.) [11

Field Museum of Natural History. Anthropological Series, Vol. 3 No. 2: Kinship System of the Seminole. By Alexander Spoeh (Publication 513.) Pp. 29–114. (Chicago: Field Museum of Natura History.) 50 cents. [13

Commonwealth of Australia: Council for Scientific and Industria Research. Bulletin No. 143: Production of Dried Grapes in Murra Valley Irrigation Settlements, 1: Viticulture. By A. V. Lyon an D. V. Walters. Pp. 48. Pamphlet No. 112: Building-Frames; Timber and Sizes. (Division of Forest Products, Technical Paper No. 36. By A. J. Thomas and Ian Langlands. Pp. 45. (Melbourne: Government Printer.) [14

Catalogues

Ilford Kryptoscreen X-Ray Paper. Pp. 6. (London: Ilford, Ltd.

Catalogue of Books on Botany and Gardening with some items o Natural History. (No. 285.) Pp. 36. (Oxford: Dulau's Departmen B. H. Blackwell, Ltd.)

Sulphonamide-*P* B.D.H. (Sulphanilamide) Pastes. Pp. 2. (London British Drug Houses, Ltd.)

A Catalogue of Books and Periodicals on Botany, Agricultur Forestry, Fruit-Culture, Gardens and Gardening, Herbals. (No. 598 Pp. 64. (London: Bernard Quaritch, Ltd.)

Catalogue of a Private Library and Books from other Source Recently Purchased. (Catalogue No. 660.) Pp. 94. (London: Franc Edwards, Ltd.)

Books on Science and its Applications and other New Acquisition (Catalogue 66.) Pp. 48. (London: E. P. Goldschmidt and Co., Ltd

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LEADERSHIP FOR THE NEW ORDER

AT a time like the present, when the war effort is rising steadily towards its maximum and fighting has intensified, there is apt to be impatience when the call for consideration of reconstruction and the future of the world is raised. Thus at the Labour conference held during Whitsuntide, criticism was directed against Labour Ministers for failing to secure more vigorous prosecution of the War, whereas long-range policy was given a subsidiary place. Nevertheless, even in the stress and turmoil of a world struggle, the foundations on which a better world shall be erected must be established ; even although it is neither possible, nor perhaps desirable, to particularize, there should be some clearer conception of the future state of society in the minds of leaders of thought than is apparent among the general public. It is the task of those who have thought about what is to follow the end of the War to prepare the minds of others. Two notable recent speeches by Mr. Anthony Eden, Secretary of State for Foreign Affairs in Great Britain, and Mr. Henry A. Wallace, Vice-President of the United States, respectively, have given valuable leads.

Mr. Eden was speaking at Edinburgh on May 8, and devoted a portion of his address to the post-war world. He emphasized that, speaking as Foreign Secretary, he had in mind particularly the problem of keeping the peace. Without peace there is nothing for the future but ever-increasing social stress ; and peace does not mean merely the absence of war. Peace in the true sense means stability in international relationships and active co-operation between all peoples ; it is an affair for long years of effort, determination and good will. A peace treaty, however skilfully and thoroughly discussed, is but the skeleton, which can only be clothed with flesh and blood by human will and perseverance. The War has demanded intense effort and sacrifice, and we must not grudge similar sacrifices for peace. Every country has a direct responsibility for maintaining the peace. The increase in speed of communication characteristic of the pre-war period has been intensified by war conditions, so that in effect the world is shrinking, and the good-neighbour policy is becoming more and more important for the future of mankind.

But just as social advancement is conditioned by peace, so is peace dependent on improvement in social conditions. Unemployment, malnutrition and low standards of life, in any country whatever, are each capable of endangering world peace. The British Commonwealth of Nations, the United States of America, the U.S.S.R. and China must therefore assume responsibility for the economic reconstruction of the world. This may mean economic sacrifices on the part of individual nations, but they will be well worth while if they can avert another world catastrophe. On a smaller scale, similar problems in connexion with the Colonial Empire will confront Great Britain ; again the answer will be sacrifice, for the greater good of the many.

Mr. Eden's speech followed closely on the heels of addresses by Sir Stafford Cripps and Mr. Oliver Lyttelton, who also stressed the needs of the post-war world. Taken together, they are an encouraging sign that members of the Government in Great Britain not only appreciate some of the difficulties which lie ahead, but also the need for bold leadership in attacking them.

Mr. Henry Wallace was speaking on May 21 to the Free World Association, and, as the 'second man' in the United States, his words obviously were intended to convey the views of the United States Government. His speech emphasized in the first place four duties—again the stress was on giving rather than receiving. Referring back to the now well-known "four freedoms" enunciated by President Roosevelt in January 1941, he said they constituted nothing less than a people's revolution, towards the accomplishment of which the present time demands four duties: to produce to the limit, to transport as rapidly as possible to the field of battle, to fight "with all that is in us", and to build a just, charitable and enduring peace. This last inspires the other three duties. Modern science, he said, is "a by-product and an essential part of the people's revolution", and by its aid it is possible to ensure that everyone has enough food. Sufficiency of food is the first requirement in raising the standard of living, which is itself an essential part of the peace which must follow this War and must embrace not only the United Nations but also the Axis Powers. Scientific developments and their applications are thus, on Mr. Wallace's showing, an integral part in the advancement of society. "Modern science, when devoted wholeheartedly to the general welfare, has in it potentialities of which we do not yet dream."

As regards the part that America will play in the future ordering of world affairs, Mr. Wallace was very emphatic that it will continue the active collaboration of which the War has seen the beginning. It may even have the privilege, he said, of suggesting the freedoms and duties of the "common man". The motive will again be service, the older nations helping to start the younger nations along the path of industrialization. Productivity must be increased, so that the "common man" and his children may repay the world community all they have received. World peace will have no place for a dominant or master race, based on Nazi or any other ideology, and with that myth must go the old conception of international cartels. Such cartels must be controlled internationally in the interests of the common man, as well as by their home Governments. Invention will thus be made to serve the many instead of the few.

These words of Mr. Wallace will be heartening to those who are striving to look beyond the immediate future. But they also demonstrate the need for fearless leadership in combating the wave of conservatism which is almost certain to come with the release of strain following upon the cessation of hostilities. Leadership, working upon a foundation of education towards the new ideals of world co-operation, can alone avert a dangerous setback.

The necessity of preparation for the changes in the ordering of society which must follow after the War was the basis of the proceedings of the second day of the annual conference of the Labour Party. The Party has a Central Committee on Post-War Reconstruction, on behalf of which a resolution was submitted affirming that "there must be no return after the war to an unplanned competitive society", and setting forth the broad principles of socialization which, in the Committee's opinion, are necessary to avert the danger. Measures of Government control have been found necessary for mobilizing the national resources in war and, it was affirmed, they are no less necessary for securing their best use in peace. While the amount, and method of exerting, such Government control, are highly controversial political questions which cannot appropriately be discussed here, the fact that the Labour Party has set up a committee to study such questions is encouraging, in that it will help to turn the minds of many, who might not otherwise give much consideration to the matter, to the urgent problems of a new world order.

While economic and political aspects of reconstruction plans were naturally prominent topics at the Labour Party Conference, the problem of the best utilization of the land and immediate post-war relief for Europe were also discussed. Sir John Orr has demonstrated the significance for the future of adequate food, proper housing and employment (see NATURE, April 11, p. 401). His own work, and that of other students of nutrition, has shown that a substantial proportion of the population of the world are living below or at the poverty line, and he has outlined a broad scheme for the improvement of conditions. The fundamentals of all such plans are based on scientific progress. Science has provided the knowledge required to improve beyond measure the well-being of humanity; but that is not enough. Scientific workers cannot stand aside when they see the fruits of their studies put to wrong uses. Herein lies a great opportunity for education and leadership. Deference is paid by word of mouth and in writing to the importance of science and scientific method in plans for the future, but there must be deeper appreciation among the rulers of the nations of all that is involved. The word 'reconstruction' must not become a shibboleth; indeed in some ways it is a misnomer, for many of the things which are passing away are outworn or have otherwise served their day. The old world order has failed to provide man with the conditions under which he can live a full life; a new order is imperative to serve the progress of civilization.

It is therefore all to the good that men everywhere should be discussing the framework of world affairs which they will wish to build. The most that can be done—and it is of vital importance that it should be done—is that the opportunities which will be afforded by the fluid state of international affairs should be widely discussed now. Thus the sacrifice inevitable in raising the standard of life throughout the world will be understood and accepted as part of the duty due from every citizen dwelling under the banner of the 'four freedoms'.

RESEARCH ON ELECTRICAL SURGES

Surge Phenomena

Seven Years' Research for the Central Electricity Board (1933–1940). (Reference S/T 35.) Pp. viii+426. (London: British Electrical and Allied Industries' Research Association, 1941.) 50*s*. net.

UNTIL the advent of the Grid erected by the Central Electricity Board during the years 1928–33, there were very few high-voltage distribution lines in Great Britain. Most of the electricity used was generated in the immediate neighbourhood and distributed by cable networks so that electrical disturbances of atmospheric origin could not affect the supply system. This situation was changed in two directions when the 132-kv. network of transmission lines was erected; in the first place, the network itself was subjected to the effects of lightning discharges which could cause damage to insulators, switchgear and transformers, and secondly, surges on the high-voltage lines were transformed at generating and distributing stations and were passed on to the lower voltage distributing systems, which hitherto had been immune from externally produced surges. Thus the Central Electricity Board and the local electricity supply authorities became more painfully aware of the effects of surge phenomena and supplied a considerable impetus to the activities of the British Electrical and Allied Industries' Research Association in its general study of surges.

The large manufacturing concerns had encountered this aggravation of Nature in overseas markets, where long-distance high-voltage transmission had been established for many years, and they had taken effective steps to minimize breakdowns due to lightning, so that much of the electrical apparatus supplied to the Grid benefits from this earlier experience. But in spite of this, there were many gaps in our knowledge of the origin, propagation and effects of surge voltages, and it was to fill these gaps that the Electrical Research Association planned an extensive programme, for which it secured extra financial support from the Central Electricity Board. The E.R.A. reports issued from time to time have been available to members of the Association and some have appeared in the *Journal of the Institution of Electrical Engineers*; but this book under notice is the first public appearance of some of the researches, and it will serve as an invaluable reference book for countless engineers and research workers in applied electricity. There is no other book on the market which treats the general subject so comprehensively, though parts of the subject have naturally been more exhaustively treated elsewhere.

The book covers the threefold aspect of surges: their generation, propagation and effects, and a further section covers the measures in vogue to protect apparatus from the harmful effects of surges and concludes with some valuable recommendations for the protection of overhead lines. Each chapter has been written by a member of the staff of the Association or of one of its contributing firms, or by a member of the National Physical Laboratory, where many of the investigations were made at the instigation of the E.R.A. Surge Committee. Thus the style varies greatly and some of the chapters are not up to date, having been written many years ago and published without substantial alteration, but these defects are not serious. A more serious defect is the concentration of some of the chapters on the E.R.A. activities to the exclusion (in places) of the work of many other investigators; in other words, the book is not the encyclopædia it could have been, emanating as it does from a large research association. Maybe the War is responsible for this; lack of time may have prevented that general detailed supervision so requisite to uniformity and comprehensiveness.

The book opens with a brilliant review of our knowledge of lightning, a chapter hot from the technical press. Papers on lightning have appeared from the pens of physicists, meteorologists and engineers, but never has such a thorough co-ordination been attempted of all data relating to lightning as appears here. Some revolutionary conceptions are introduced, in particular the potentials of thunder clouds to ground, and the nature of the stepped-leader stroke discovered by Dr. B. F. J. Schonland in South Africa. It is even suggested that the nature of the lightning flash may be modified by the resistance of the point of contact of the flash to ground. The authors analyse some of the results of other workers which appeared at variance with established ideas and find a true harmony to exist. There follow descriptions of methods of recording surge voltages and currents, and a chapter on lightning research sponsored by the E.R.A. in Nigeria. Similar expeditions have been equipped in only a few other countries, and it is a matter of regret that the War has necessitated the cessation of this interesting and promising field of research after only two lightning seasons.

Faute de mieux, the E.R.A. has made the best use of man's puny imitation of lightning. Section 2 describes the generation and recording of artificial lightning, or impulse voltages, and the propagation of surges on transmission lines, two lines, one for 33-kv. and one for 132-kv. being made available by the Central Electricity Board for this purpose. The section opens with a mathematical treatment of wave transmission on overhead lines and cables. Lord Rutherford remarked that a mathematical theory is only of use if it gives a clear picture of the physical processes involved. In this chapter the reader is given a very clear picture of the effect on a travelling wave of the many factors encountered on a line: line resistance, line termination, overhead earth return wires, neighbouring conductors, lengths of cable, and corona.

For surges of amplitude below the corona onset voltage, attenuation due to skin effects is not appreciable, although in a few miles from the point of origin the rate of rise of voltage is very considerably reduced. This factor alone must be very beneficial in safeguarding inductive apparatus, in which stress concentration is greatest when the rate of rise of applied voltage is a maximum. If, however, the surge voltage exceeds the corona onset voltage, attenuation is very rapid apart from reduction of rate of rise of voltage. Thus in an example worked out in this chapter, a wave of ten times the corona voltage is reduced to one of five times the corona voltage in two miles. This chapter is well supported by the chapters describing tests on a 33-kv. and a 132-kv. line. In each case, below the corona limit attenuation was found to be small, so that waves propagated just below the corona value will probably reach terminal stations and be doubled by reflexion. These values may be serious for owler-voltage installations but not for the high-voltage lines where the margin between operating voltage and corona voltage is meagre. Above the corona limit, the oscillograms show how the travelling wave is sheared off, resulting in a pronounced change of wave shape which renders the surge far less harmful. The voltages induced in neighbouring phase conductors were studied on both systems, and it was shown that the induced waves might have amplitudes large enough on reflexion to cause sparkover. It appears certain that 3-phase surges will frequently be encountered at terminal stations. The section also includes a description of the apparatus used in the study of surge propagation, namely, the impulse generator and cathode-ray oscillograph.

Section 3 deals with surge voltage distribution in transformers, a subject on which there is an extensive literature but one on which finality has not been reached. The main contribution in this section is the study of the effect of increasing the end-turn insulation in transformers, and the old deduction that the provision of additional insulation on the end-turn does not incresae the safety of the winding is redetermined by a careful oscillographic study. Unfortunately, the results are not substantiated as one would like to see them, by actual tests to breakdown of normal and reinforced insulation. The transference of surges from one winding to another is skilfully handled, and the specially dangerous conditions relating to the open-circuited transformer are emphasized. The subject is very complicated on account of the wide variety of transformer designs, and the treatment here deals only with the straight concentric winding. Manufacturers will be aware of the great difficulty of extending these results to the many cases of complex windings encountered in practice.

The section on surges on insulation deals only briefly with a few classes of insulation, solid dielectrics, cables and insulators. It is of interest to note that in the brief reference to co-ordination of line insulation, the insulation levels for the main part of the transmission line, the line near stations, and the protective gap of the station are separated by good margins of 25–30 per cent, instead of the meaningless margins of about 10 per cent which have been discussed elsewhere in the past.

The fifth and last section deals with the measures employed to protect against the harmful effect of surges. These consist of means for diverting lightning strokes from electrical apparatus, and means for reducing the amplitude or gradient of the surge voltages arriving at electrical apparatus. The critical résumé of the literature on the protective range of lightning rods brings out the danger of basing deductions as to the probable behaviour of lightning on tests carried out on models. It is unfortunate that the chapter does not give more data on the effect of different dispositions of earth wires relative to the three-phase conductors, information known no doubt to the large supply authorities. The various devices in past and current use for shunting surges to ground or modifying their wave shape are described, and tests made on many of these by the National Physical Laboratory are given in detail. The proposed international specification for lightning arresters was under discussion in 1939, and the National Physical Laboratory views on the clauses are given here in the light of experience gained in testing various makes of arrester.

Surge absorbers or wave modifiers were also tested at the National Physical Laboratory. Some behave as capacitors, others as combinations of inductance and capacitance, while a third modifier designed by the E.R.A. comprises an inductance with negligible capacitance to ground, a spark gap in the form of an expulsion tube on the line side of the modifier to ground, and a damping resistance which is switched in parallel with the inductance by another spark gap having a short time lag. Thus up to the instant of breakdown of this latter gap, the voltage rise on apparatus connected to the modifier is determined by the inductance of the modifier and the capacitance of the apparatus, and therefore begins to rise slowly in the 1-cosine form, but after gap breakdown the advantages of damping are realized. The final chapter summarizes the merits of the various protective devices and makes recommendations for system protection under a variety of conditions.

Two aspects of surges are omitted. Practically no reference is made to surges due to switching phenomena, and no observations by supply authorities relating to surge phenomena are given.

T. E. Allibone.

A MYSTICAL PSYCHOLOGY

The Psychology of C. G. Jung

An Introduction with Illustrations. By Dr. Jolan Jacobi. Translated from the German "Die Psychologie von C. G. Jung" by K. W. Bash. Pp. xi+169. (London: Kegan Paul and Co., Ltd., 1942.) 12*s*. net.

THE evaluation of Jung's contributions to psychology and psychiatry is by no means an easy task. His earlier achievements were as scientific as any made before or since in these difficult subjects. His book called "The Psychology of Dementia Precox" was a careful clinical study and showed that he was capable of exact observation. Again, his "Diagnostische Assoziationsstudien", which recorded his careful researches upon reaction times and their relation to unconscious emotion, proved the existence of those constellations of ideas and emotions which he formulated as "complexes". Adler has made so much of the "inferiority complex" (by which he meant feelings of inferiority and not a complex at all) that too often it is forgotten that it was Jung who first conceived the idea of the complex. Nothing could have been more promising than these observations based upon careful measurement. One might have thought that here at last clinical research was attaining definite scientific basis. In spite of this we cannot agree with Dr. Jolan Jacobi that "As a didactic and diagnostic method it has become an essential aid to all psychotherapy and belongs to-day to the standard equipment of psychiatric institutions, clinical psychological training and vocational guidance of every kind, and even finds its use in the law courts" (p. 38). Such a eulogistic description of controlled association is scarcely true—at least in Great Britain—but nevertheless by his careful investigation into reaction times Jung had made what appeared to be a fruitful start.

This work was performed between 1905 and 1907. It was in the following five years that Jung abandoned his clinical work and most unfortunately started upon the study of religions and myths. The result of this preoccupation was the publication of his work on "The Psychology of the Unconscious" which appeared in 1912. It is not exaggerating to state that Jung seems to have forsaken science for religion. This book caused his secession from the Psychoanalytical Society and made a schism with Freud. From then on he formulated his views uninfluenced by others. He developed the idea of the libido existing not as a physical craving as Freud envisaged it but as Dr. Jacobi defines it as "the totality of that force which pulses through and combines one with another all the forms and activities of this psychic system" (p. 50). In practice it appears to erupt in conceptions of gods and demons.

Jung made an attempt to return to clinical medicine in his publication of "Psychological Types", in which he described the extravert and introvert. This phase did not persist, and his later books have tended more and more towards obscurity and mysticism. Dr. Jacobi tries to refute this accusation of mysticism by comparing Jung's psychology with the conclusions of Whitehead and Eddington (although these also have been accused of the same fault) but does not do so very effectively. She says: "Before the word 'mystic' one no longer needs to feel the customary dread—above all, not to confuse it with cheap irrationalism, for it is precisely reason that here presses forward to its own limits, as modern logic likewise honestly attempts to define its own boundaries, not, as it were, by rejecting but by logically establishing the independence, indeed when one has rightly defined and thereby delimited the concept of 'cognition', the sovereignty of the 'mystical'" (p. 64). In spite of this attempt to cut the ground away from the critic, it is difficult to describe otherwise than as mystical and obscure the following passage from Dr. Jacobi's book: "The making conscious of those contents which constitute the archetype of the mana personality signifies therefore 'for the man the second and true liberation from the father, for the woman that from the mother, and therefore the first perception of their own unique individuality'. Only when he in the true sense of the word 'becomes united with God in spiritual childhood'; and then only if he no longer 'blows up' his thus broadened consciousness in order 'thereby paradoxically to lapse into a flooding of his consciousness by the unconscious', i.e. an inflation. Such presumption would indeed, in view of the deep insights he had won, be not astounding; everyone falls victim to it for a time in the course of the individual process" (p. 117).

Well might the reader ask what all this means. Does it imply that the patient might become conceited? One hesitates to say, but Dr. Jacobi states that such nonsense "is likely to have a decisive influence on the formation of the future conception of the world".

If we turn from the consideration of Jung's philosophy to Dr. Jacobi's exposition of it we must admit that her book is thorough and careful. She has made an honest attempt to expound Jung's difficult conceptions, and those who read it will gather some outline of the copious outpourings of the master. The book is divided into three parts: (1) The Nature and Structure of the Psyche; (2) The Laws of the Psychic Processes and Operations; (3) The Practical Application of Jung's Theory. There are a large number of diagrams, but whether they clarify the subject or not it is difficult to say. The book ends with a biographical sketch of Jung's life which seems rather inadequate. There is a complete bibliography (perhaps the most valuable part of the book) which extends to fourteen pages and includes a list of all works in the various languages into which his writings have been translated. There is an index of four and a half pages which seems adequate for a book of this size.

Clifford Allen.

A SOCIAL REVOLUTION

Science and Human Prospects

By Prof. Eliot Blackwelder. (The Thinker's Forum, No. 19.) Pp. 32. (London: Watts and Co., Ltd., 1942.) 6*d*. net.

THE revolution which is in full swing might be dated for Great Britain from mechanical inventions of the latter part of the eighteenth century. She has dealt with scientific and mechanical changes rather than social or governmental, because British history has on the whole been peaceful; but she was able by her resources of coal and iron and the mechanical inventions to beat her neighbours in trade as well as at sea.

It is not necessarily beneficial to undertake a revolution and therefore it would be well in the present movement to specify the good and what might be the better. Prof. Blackwelder's little book suggests some points.

(1) Mechanical force has now been carried almost to the extreme. The steam engine has come into its own. The result of this is the multiplication of the workpeople and the turning of a countryside into a town.

The first fruits of applying science to industry are not all good—great wealth for the proprietors but an ill life for the workpeople. The early part of the last century began the revolution to remedy this. A minimum of welfare was insisted on in factory legislation, and minimum rates of pay were afterwards secured, partly by union action, partly by the State.

(2) The second part of the revolution is ultimately superior. The State by the end of the century had taken education under its care. The English plan in education as well as government is to keep the best of the old and widen as far as resources yield. Although the level is low, knowledge, taste and goodwill to others have increased enormously.

(3) It has often been said that Christianity was never really active until the nineteenth century. And in these later appeals, it is noticeable that freedom is good for health. A benevolent and not dictatorial State is the ideal of the latter part of this revolution. As humanity has come together by the appliances of science, so it must work for higher things in art and music. The outbreak of industrial imperialism which stamped the latter part of the nineteenth century did not aim mainly at the higher things. They are the passionate quarry of the present crusade. A good life for all: any goodness being aimed at, it is seen that religion pervades the whole. Strange that a hundred years ago it was not regarded as irreligious to make fortunes for the few and neglect and degrade the multitude. Is it degrading to work?

The revolution through which we are now passing, aims at something far higher than before. The whole community shares and the State is the ultimate authority; and there will be as many intermediate bodies as needed, for education, for transport, for music and many more agencies, leading always to free initiative.

Beyond this, and more important than this, comes the international body. In this Great Britain will be preponderant, but other States including Germany will have their place. The United States will be at our side and we shall avoid the errors of 1918 in making treaties and excluding the enemy. We cannot believe in a final step back. Humanity which grew out of Western civilization will triumph. It may be long.

F. S. Marvin.

SCIENTIFIC STUDY OF SOCIETY

By DR. HENRY A. MESS
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The Natural Sciences and the Social Sciences

THE lengthy correspondence in *The Times* a few months ago, a number of articles and letters in NATURE, and the discussions at one or two conferences, all bear witness to the widespread interest in the scientific study of society. They also show a certain amount of confusion of thought and some lack of information as to what is actually being done.

It is natural that there should be this interest at the present time. We have all learned some bitter lessons in the last few years. Among other things we have discovered what great disasters can come upon mankind through science. It was stated recently that one of the first men to fly, an old man now, is heartbroken by the knowledge of what flying has actually come to be. Nobel, who developed the manufacture of high explosives, was similarly saddened by the use to which they were put.

But we cannot turn our backs on science. Nor is it the development of science which is the real evil; it is the lop-sided development of science. It is the rapid growth of the natural sciences without a corresponding growth of the social sciences which has brought such dangers and disasters on us. This is now generally recognized, not least by the natural scientists.

The contrast between the competence of men in some directions and their incompetence in other directions has become a commonplace. Men can mould matter and use physical forces with remarkable facility. They have made the fairy tales come true; they can fly in the air, they can travel under the sea, they can penetrate the recesses of mountains, their whispers can be heard across continents and across oceans; they can work wonders with living matter, they can bring into existence new plants and new breeds of animals. Yet with all these powers at human command, there are millions who are imperfectly nourished, millions who are badly housed. Wars persist, more horrible because of our science. In the intervals between wars there is social strife; and we have the bitter paradox that when our manufacturers and our farmers produce abundantly, they are in danger of being ruined by low prices. Recurrent periods of unemployment blight the lives of multitudes. All this we seem to be unable to prevent.

The contrast between achievement and futility is glaring; and it is a challenge. What response to it shall we make? The answer is obvious. Since we cannot turn our backs on science, even if we would, we have no option but to go forward, to apply science to those spheres of human life in which at present we are so incompetent. Inevitably the question is being asked, more and more insistently, whether the application of scientific methods to the study of society cannot give us a control over social processes comparable to our control over physical forces. Can we find a remedy for the evils, of which we are so sensible, in a scientific study of society?

The answer is being given quite rightly that we can; a great increase of knowledge and a great increase of control are certainly possible. But having said that, it is necessary to give a warning. To argue directly from what the natural sciences have done to what the social sciences might do is unsound. The social sciences are bound to be very different from the natural sciences. Their subject-matter is differen The chemist and the physicist have to do wit inanimate things, which do not have moods and will which do not alter just because they are bein examined. The social scientist is dealing with nothin so consistent, nothing so tractable; he is dealin with the relations of human beings, consciou sensitive, wilful, living creatures. If anyone think that we are likely to obtain laws of social development as precise and as little subject to variation a the great physical laws, he will pretty certainly b disappointed. It has hindered, and not helped, th social sciences that some of their practitioners hav made exaggerated claims on their behalf. What ca be claimed fairly is that the social sciences ar capable of helping us to a much better understandin of the present and to a much clearer perception o the possibilities, the impossibilities and the probabilities of the future.

It cannot be said too emphatically that we nee to be clear in our minds as to the distinctive nature and roles of the physical sciences and the socia sciences. The former can contribute much to huma welfare, as also much to human unhappiness; w need to think hard how to make the best of thei contribution, and to do so will call for co-operatio between physical scientists and social scientists. I this the former have a big part to play. But the cannot help much in what is one of the most urgen tasks of men to-day, the analysis of the nature an functioning of societies with a view to increasin our control over social forces. The physical scientist and the social scientists have really very little i common. Of course, they must both be objective and they must both follow the rules of logic. Bu that is about all they have in common. Only har is done if any attempt is made to force the method or the canons of one upon the other. The chemis can experiment and weigh, and he can hope fo exact results. There is only a very restricted fiel for experiment in the social sciences, and the socia scientist is bound to take into account much tha cannot be measured, but can only be assessed hopes and fears, prejudices, the force of custom, th power of ideas. Some grotesque results have bee reached when attempts have been made to measur that which is not really amenable to measurement and, let us repeat, findings must often be stated i terms of alternatives and of probabilities. Fo example, I think that the majority of competen students of local government in Great Britain woul say that *either* local government areas will be revise and enlarged *or* local authorities will decline in powe relatively to the central government departments Again, there is a strong likelihood that a defeate nation will develop within a decade or two a hars and aggressive nationalism; but alternatively i may fall into a state of apathy and accept a positio of permanent inferiority; or, more rarely, it ma bend its energies to finding an idealistic solution of it difficulties, as Denmark did after 1864. It is impossible to say for certain which of these will happen but it is very likely that one of them will happen

The case is rather different with regard to th biological sciences. But here also we need to distinguish between the utilization of their findings fo the advancement of human welfare and the mor specialized task of analysing society. As an exampl of the former, we may take the impact upon publi opinion of the researches of the dieticians. Clearl we are in deep debt to them, and clearly to maximiz the utilization of their work there must be co-operation between physiologists and social scientists. In the same way there is a good deal of psychological knowledge which can be used. So far there is a parallel with the utilization of the work of the physical scientists. But in addition, the biologist and the psychologist have their distinctive contributions to make to social analysis. The biologists can tell us a good deal about the inheritance of intellectual ability, about the effects of marriages between persons of different race, and so on. The psychologists have taught us a great deal about the workings of the human mind, about the way in which the emotions can distort reasoning ; we have such topical studies as Prof. F. C. Bartlett's examination of propaganda[1].

But while biologist and psychologist, and let us add economist, can throw a good deal of light on the functioning of society, and while each of them can do what no unqualified person can do, yet we should be still far short of an adequate analysis of society. In isolation the various social scientists are liable to fall into serious error, as the literature of eugenics and the long-drawn-out controversy with regard to instincts in man abundantly testify. A correct and an adequate analysis of society cannot be made by biologists only, or by psychologists only, or by economists only. There can only be an accurate and an adequate study of society when the different social sciences are related, and when there is team-work between those who practise them. This has always been a first principle of sociology, which is the general study of society.

The scope and methods of sociology are so commonly misunderstood in Great Britain that it is well to elaborate this a little. Comte's doctrine of the "social consensus" needs modification and re-statement; there are more partial autonomies in the social structure than he realized. Yet that there is an interplay of the various parts can scarcely be doubted, nor that it is intricate and important and needs careful study. Such study is undertaken by the sociologist; and because he is always aware of the interdependence of parts, he views society holistically. The objection generally raised is that the sociologist is attempting too much, and that he trespasses on too many fields. If the sociologist attempted to do the work of the biologist, the psychologist or the economist, that objection would be justified. But it is not so. The sociologist accepts the findings of the specialists ; his business is to relate those findings, and to use them in the interpretation of the society which he perceives as a whole ; sometimes also it is his business to make the specialists aware of alternative explanations of social phenomena. Doubtless to do this he requires some elementary knowledge of a number of social sciences, but that is very different to claiming to be an expert in them. It is probably desirable that a sociologist should be really well equipped in at least one specialist social science. That is one of the ways of advance ; another is to secure that an increasing number of specialists in one or other of the social sciences have a background of general sociology.

It should be added that the sociologist has also one or two specialisms of his own, parts of the field of social study which have not been annexed by any special social science. Of these specialisms quite the most important is the study of social institutions. Such a book as Westermarck's "History of Human Marriage" falls within this field.

Practical Applications

When we are considering what practical benefits the scientific study of society might confer upon mankind, it is useful to distinguish between short-range and long-range inquiries. By short-range inquiries I mean those which are concerned with the problems of a particular society in a particular age. For example, the evacuation of school-children during the present War has presented what I should call short-range problems ; the distresses of the Special Areas a few years ago were short-range problems, the many difficulties which arose in connexion with re-housing were short-range problems. The long-range problems are those concerned with social phenomena which are to be found everywhere and always, with such difficult questions as the limits within which human nature can be altered, or the causes of the rise and fall of civilizations.

Now with regard to short-range problems a great deal of advance could be made very quickly. It is largely a question of money ; and if more adequate provision is made for the social sciences we can soon produce and employ men and women who will throw a great deal of light on our social problems, and who will ease greatly the process of dealing with them. It would not be difficult to draw up a list of short-range problems which could be investigated very profitably. Here, for example, are three suitable subjects for inquiry : (1) the difficulties and the effects of migration within Great Britain ; (2) the conditions favourable and unfavourable to the growth of civic consciousness and local patriotism ; (3) the social life of various types of English towns. On all these subjects something has been done, but not enough. There is much scattered material on internal migration in Government publications and in books dealing with unemployment and the location of industry ; there is an interesting unpublished study of assimilation in the East Kent coal-field ; but it cannot be said that there has been any adequate sociological study of this social phenomenon which is as interesting as it is important. With regard to the conditions affecting civic consciousness a great deal can be learned from the experiences of the new housing estates, as Mrs. Durant's fascinating study of the growth of Watling has shown us ; her investigation might have been multiplied many times with great advantage. As to studies of particular towns, it is lamentable that we have not as yet any study of an English town which can be set alongside R. S. and H. M. Lynd's "Middletown" and "Middletown in Transition".

Such studies are not mere academic exercises ; they supply knowledge much of which could be put to immediate use. Sociologists are in a position to render useful service to Government departments and to local authorities. After the War we shall be building a good many more new estates. A sociologist could point out ways of shortening the process by which a mere collection of houses and of families becomes a true society. In the same way, there is bound to be fresh migration, and a sociologist could suggest ways of easing the strains which there are sure to be when men and women go to live among strangers. I venture to prophesy that the quality of social life in our smaller provincial towns is likely to be in the near future a matter of public concern ; here again the sociologists can be of use, though they will be handicapped for lack of those preliminary studies which might have helped them.

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[1] "Political Propaganda", by F. C. Bartlett.

Much assistance could also be given in the sphere of international relations. Prof. C. E. Merriam, of the University of Chicago, with a team of co-workers, has reviewed the methods adopted in various countries to inculcate patriotism. Quite a deal could be learned from those studies which could be applied to the task of creating as quickly as possible a strong loyalty to a reconstructed League of Nations or whatever other supra-national body there may be set up after this War.

The long-range problems are another matter. With regard to these, the number of men and women who are competent to do effective research is likely to be small, and progress is likely to be slow. But sustained research might in time yield results of quite incalculable value. For example, how little we really know at present about human nature, about its variations, how far it is capable of change, to what extent it is the same always and everywhere. Yet there is a vast amount of material existent in the writings of historians and of anthropologists which, if it were carefully examined, might yield valuable results.

Here let me digress to emphasize the very special case which can be made out for generous support of anthropological research. I am not an anthropologist, but, like all sociologists, I am deeply in the debt of the anthropologists. Their special claim derives from urgency; the material upon which they work, the simpler societies, is fast vanishing; investigations which are not made in the next few decades will probably not be made at all; and these investigations throw light on social structure and on human nature which we are scarcely likely to obtain from any other source.

It is, I think, almost essential for effective study of long-range problems, and for that matter it is often desirable for the study of short-range problems, that there should be team-work. A society is a whole, and it needs to be studied as a whole; and that means either the co-operation of many specialists or the work of a man of encyclopædic knowledge. Men of the latter type are rare, are perhaps likely to become rarer. It is to team-work therefore that we must look more and more. But the planning of work by a team, and the intelligent co-operation of team-workers, both demand that knowledge of the interplay of the different factors in social life which is the special subject-matter of sociology. Everyone praises his own leather, and I do so unashamedly; it seems to me deplorable that the persons in Great Britain who have been appointed specifically to teach sociology can be counted on the fingers of one hand.

Whether that be accepted or not, there is at least widespread agreement that we need to take more seriously the scientific study of society. Concretely, that means better provision in the universities, more chairs and and more lectureships, more post-graduate studentships. It means better utilization of the already considerable knowledge of social scientists, and an enlargement among other things of the number of careers open to them. It means better understanding and more team-work among them. There is also a great work of popular education to be done. We need to increase immensely the number of those who have some scientific knowledge of the nature and functioning of society. When such knowledge is greater, and when it is more widely spread, we shall be on our way to a considerable measure of control of social forces; and we shall increase the use and decrease the abuse of the abundant knowledge placed at the disposal of mankind by the natural scientists.

WEST INDIAN AGRICULTURE

By SIR GEOFFREY EVANS, C.I.E.

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WEST Indian affairs attracted considerable public attention in the period immediately prior to the outbreak of the present hostilities. Severe economic depression and the deplorably low standard of living had indicated that all was not well and general concern was manifested by the Imperial Government. Signs of considerable distress and labour unrest, culminating in disturbances in various Colonies during the late thirties, resulted in the appointment of a West Indian Royal Commission which toured the various Colonies in the Caribbean area during 1938–39, with the object of making specific recommendations. Unfortunately, the report of this Commission has not yet been released, but the main conclusions reached and certain recommendations made were published in February 1940 (Cmd. 6174). Now apart from Trinidad, which has a big petroleum industry, and British Guiana, which has developed bauxite mining and to a less extent gold and diamond diggings, all these Colonies depend entirely on the agricultural industry for their prosperity. The recorded opinion of the 1938–39 Royal Commission that "agriculture is the principal source of sustenance and wealth in the West Indies and the standards of life must largely depend on the intensive use of the soil" therefore accurately portrays conditions.

It is obvious from this that the betterment of agricultural practice underlies the whole problem of social and material progress in this area. The problems involved are intricate and not easy to solve, and it is opportune, therefore, that H.M. Stationery Office should have been able, even in these difficult times, to publish a book entitled "Agriculture in the West Indies" (Colonial No. 182), which gives a very complete and up-to-date description of conditions as they were just prior to the commencement of this War. The book has been compiled by Dr. H. A. Tempany, agricultural adviser to the Secretary of State for the Colonies, from documents supplied to the West Indian Royal Commission, and from other sources. It forms a valuable record of agricultural conditions in each Colony at the present time besides giving historical data which undoubtedly have considerable bearing on the existing state of affairs.

Unlike most other tropical areas, the West Indies have had no tradition of native agricultural practice to build upon, for the native Indian tribes rapidly disappeared under the Spanish rule which was established at the end of the fifteenth century, and the labour required for development was afterwards met by the importation of Africans and later, after the abolition of slavery, by indentured labour from India and to a lesser extent from China and the Portuguese Atlantic Islands.

As is pointed out in the book referred to above, the system of agriculture is really based on the methods in vogue in Great Britain and the European Continent before the great renaissance of the eighteenth century, with its development of rotations and mixed farming, took place. The negro brought few ideas with him, but perhaps insufficient credit has been given to the changes that have been introduced by the immigrants of East Indian origin. For example, it is perhaps not too much to say, that without the help of their traditional art, the development of the rice industry, which shows considerable progress in British Guiana and could, with a little encouragement, be developed much more in parts of Trinidad and Jamaica, would probably never have taken place so rapidly as it has, for the man of African descent has shown little inclination or aptitude for this type of cultivation.

Throughout the last three hundred years, agriculture has been based on the plantation system, which was first established by the Spanish, and later continued by the French, English and Dutch, when they in their turn began to acquire interests in the islands. Under this system, the land belonged to the planter, who farmed the whole estate with the aid of labourers. The latter owned no land and were not encouraged to cultivate crops for themselves. The crops raised were mainly for export. Sugar-cane has always been the staple plantation crop, and the prosperity of the West Indies may be said to have depended to a large extent, as in fact it does to this day, on the condition of the sugar industry.

Other plantation crops have had their ups and downs. Thus, cotton was cultivated on a large scale at the time of the American Civil War when supplies from the United States to England were interrupted. It ceased to be profitable when peace was declared, and all the memory that is left of it on many of the islands is hillsides covered with poor secondary bush, which are eloquent of the soil erosion that must have taken place during that period. The cacao plantations were started later during one of the periodic depressions in the sugar industry, much of the planting being done at the end of the last century and the beginning of the present one. Cacao is still a major crop in Trinidad, Tobago and Grenada, but is at present in a depressed condition owing to competition from West Africa and Brazil and the ravages of disease.

The cultivation of bananas for export began in a small way in Jamaica during 1868–69. It is somewhat curious that, like sugar-cane, it is not a native of the area, as the Gros Michel banana, which is the commercial variety, undoubtedly originated in the Far East. With the development of better methods of transport, a huge export trade arose and the average exports for the three years previous to this War were in the neighbourhood of twenty-three million stems a year. Now the banana in its turn has become subject to diseases and many growers have had to try to turn to other crops, and, as is the case with cacao, some of the land is going back to cane.

All through their known history, the West Indian territories have been subject to periods of intense depression, which have necessitated the holding of special commissions and inquiries. Prior to the recent commission, probably the most important one was the Royal Commission of 1897 because it did result in certain definite changes for the better. The sugar industry at the time was in the depths of depression; competition with beet sugar, grown under a system of bounties on the continent of Europe, was being severely felt and the Bourbon cane, which was the principal variety, was succumbing to disease. The Commission recommended the thorough overhauling of the sugar industry, the abolition of the sugar bounties, greater diversification of agriculture, the establishment of small holdings, together with the encouragement of peasant agriculture and the placing of scientific research on a proper basis. Many of the proposals were in part at any rate carried into effect. The sugar industry was overhauled and much centralization took place, leading to the amalgamation of many small estates, the adoption of better methods, and higher extraction in the factory. The sugar bounties were abolished in 1903.

An Imperial Department of Agriculture was established in 1898 and the cost of the operations were paid by the Home Government for ten years. Its headquarters were at Barbados, and it operated chiefly in the Windward and Leeward Colonies, but its influence and the results of its researches were felt throughout the archipelago. Much was done to encourage diversification of crops, one of the outstanding successes being the establishment of the Sea Island cotton industry, which is proving its value for war needs at the present time. New varieties of cane were introduced and cane-breeding operations fostered; chemists began to examine the soils and pathologists to investigate plant diseases and pests. In due course similar departments were organized for Jamaica, Trinidad and British Guiana, and in fact most of the agricultural departments now functioning in our tropical Colonies may be said to have had their inception and to be modelled upon the old Imperial Department of the West Indies.

The 1914–18 war period brought high prices and prosperity to the West Indies. The witchbroom disease had not yet appeared in Trinidad's cacao fields, which were at that time in their prime. Panama disease and the Cercospora leaf-spot did not then worry the banana plantations of Jamaica, and the lime producers of Dominica and St. Lucia obtained good crops and good prices, as the wither tip disease only appeared later. But after the short post-war boom, prices fell to a catastrophic extent and in many cases it appeared that the old plantation system was breaking down and would be unable to cope with modern conditions unless considerable modifications and adjustments were made.

The demand of the peasants to own land has been strongly in evidence for years past. It was brought forward at the time of the 1897 Commission, and following its recommendations, some land settlement was actually started in St. Vincent and other islands. These early settlements were comparatively few in number, but their history is interesting and the experience gained should prove most useful at the present time when, as a result of the work of the latest Commission, the need for the development of peasant agriculture has again been stressed. It is not too much to say that the early settlements were not an unqualified success; many of them proved failures due to lack of accurate information and knowledge of the underlying factors involved.

One of the reasons why the demand for land settlement has become so persistent in recent years is the increase in population. Formerly, an appreciable proportion of the labouring population found an outlet for their energies in neighbouring countries. A number emigrated and others found profitable employment for periods of the year in the cane fields of Cuba and other countries. It must be remembered that West Indian labour was largely drawn upon for the construction of the Panama Canal and the opening up of the oil industry in the Central American Republics. These developments offered employment at lucrative rates. The money thus earned enabled the labourer to maintain his family and household in his native island and resulted in the inflow of an appreciable amount of wealth from outside. Within the last ten years or so, this state of affairs has come to an end and immigration laws have curtailed the activities of the West Indian, who nowadays is forced to try to find his living in the British Colonies.

The difficult problem of finding a livelihood has, therefore, become aggravated. Some of the islands are really densely populated. For example, Barbados, which is about as big as the Isle of Wight, has a population of 1,163 to the square mile; Jamaica, the largest island, had a population of 1,173,600 in 1938, with a density of 263 per square mile, and had increased its population by more than 300,000 in eighteen years. For countries which depend entirely on agriculture and have no industries to speak of, these densities are high. The possibility of relieving the pressure by emigration has exercised the attention of many administrators in recent years. Unfortunately, the other islands are mostly already fully occupied and offer little scope, and the possibilities of the two mainland Colonies of British Guiana and British Honduras have frequently been considered. These two Colonies certainly have the area, and on that basis alone are considerably under-populated. The same might very well be said of Australia.

If one examines the facts, however, it is found that although British Guiana covers an area of about 90,000 square miles, and is, therefore, larger than England, Scotland and Wales put together, eighty-seven per cent is under heavy tropical forest, ten per cent under savannah, and only three per cent on the coast is cultivated. The old idea that land producing heavy rain forest in the tropics must be fertile has been largely exploded, and as a matter of fact the soil underlying these British Guiana forests is singularly poor, and as the few experimental settlements have proved, is incapable of supporting permanent agriculture. The same may be said of the savannah soils. These are also infertile and lacking in essential mineral salts. They at present support a small ranching industry, and it would seem that future developments would lie in the direction of improving the methods of cattle raising. It is possible, even, probable, that the forestry industry may be scientifically exploited after the War, even though tropical rain forests are difficult to develop commercially because of the multiplicity of species they contain. Neither the cattle industry nor forestry will, however, be in a position to afford relief to the congested populations of the islands, even if the latter could adapt themselves to work which is specialized and to which they are not accustomed. In British Honduras again, forests predominate, and the evidence is that good agricultural land is strictly limited.

The best means of helping British Guiana at present lies in providing proper irrigation and drainage facilities in the frontal lands, with the view of developing land settlement with paddy as the basic crop, as the conditions are specially suited to this kind of cultivation. The peoples of East Indian origin are skilled in this form of agriculture, but it is more than doubtful whether immigrants from the islands, the majority of whom would be of African descent, would be able to settle down to it. It will be seen, therefore, that the two mainland colonies do not seem to present an easy solution to the over-population problems of the islands, and it is evident that these islands will have to try to find the solution within their own confined boundaries, so long at any rate as the present social and political restrictions affecting emigration continue.

There is no doubt that many of the islands could support a larger population if all the land available for agriculture were properly utilized. As already indicated, many of the plantations have become derelict and many others are not producing anything approaching their maximum. In many instances the estates are heavily in debt, with the result that considerable capital expenditure would be necessary to make them once more productive. But the owners usually find it impossible to obtain the necessary money to provide for the drainage and replanting and similar operations essential to maintenance of production. The long period of depressed markets has found the owners already mortgaged, and in many cases they continue to use out-of-date methods, so that they are in no condition to tide over bad times. The sugar industry has been able to carry on, though with difficulty, because the smaller estates have combined, the factories have been centralized, modern machinery installed, and scientific inquiries sought and new methods adopted. This was not the case with the cacao, the lime, and, to a less extent, the coco-nut plantations. These crops do not lend themselves so readily to centralization, and as a result many of them have become derelict. It has long been evident that some drastic measure would be needed so that the proper utilization of the available land might be able to meet the situation created by the rising population. Change of ownership and experiments in land settlement with peasant smallholders seem to be the inevitable outcome.

Another matter that has given grave concern is the great dependence of the islands on imports for the food supply. The tradition of the West Indies has been to grow crops for export. In Barbados, for example, the estimated value of the food crops actually home-produced in 1938 was about £135,000, while in the same year the food imports were £516,000 and animal foodstuffs another £78,000. Further, much of the food imported was not of high nutritional value, with the result that the public health authorities were gravely concerned about the malnutrition that was evident. The other Colonies show a similar dependence on imports for their food supplies, although to a less spectacular degree. These islands would be in a serious quandary if anything should happen to upset the smooth working of the shipping lines, as is likely to happen in time of war. A change of policy has, therefore, appeared in the last few years, hastened of course by the advent of the present War, but already seriously considered for some years previously. It is now generally accepted that these Colonies must be more self-supporting in food supplies and should endeavour to produce food of better nutritional value than much of that which is now imported.

The decision to open land settlement was made before the War, and the Governments of the most densely populated islands are taking the steps within their means to acquire suitable estates and settle them with peasants on small holdings. St. Vincent made a start at the beginning of the century. Jamaica has recently done much in this connexion, as in 1938 a sum of £650,000 was raised on loan by the Government to extend settlement further, and a separate Department of Land Settlement was formed. In the Leeward Islands, also, a good start has been made by the purchase of estates in Nevis and Antigua, and the other Colonies have taken similar action. It may be taken, therefore, that a commencement has been made; but it is necessary to sound a word of warning since the technique of successful land settlement in the tropics is not easy, and has many pitfalls. There is the matter of the form of land tenure, for example.

The demand for freehold is great. Naturally, everybody wants to own his bit of land, but Government has definite responsibilities in this direction that cannot be disregarded. It must be remembered that land is precious in the West Indies, and the pressure of population is great. Experience with the older land settlement has shown that there is a tendency to exploit the land. Steep slopes have been deprived of their tree cover for cropping, with the result that much of the soil has been lost and periodic floods have caused destruction lower down. Repeated cropping, without manuring, has impoverished the land, and so on. One could mention some of the older settlements of the islands where the land has been completely ruined in fifteen years and the settlers have then demanded to be placed on fresh land. Instances of this sort can obviously not be repeated on a large scale, because the area of cultivable land is limited and the soil once lost cannot easily be replaced, and so the time might arrive when there would be no worth-while land left for anybody.

In fact, the sooner it is recognized that the soil is the main, and in many cases, the only asset the islands possess, the better it will be for everybody, for once lost it cannot be recovered. The granting of freehold is a matter that needs very serious consideration, therefore, but whatever form of tenure is finally selected, reasonable security must be offered, so as to give the peasant the chance to improve his holding. Without such security, there will be the natural tendency to 'skin' the land. On the other hand, the Government must be in a position to remove anyone who disregards the rules safeguarding the land and adopts methods that result in soil erosion and impoverishment.

The plan is to adopt a system of mixed farming, involving rotational cropping and including the keeping of livestock. The main object of introducing livestock is to provide for a supply of pen-manure and so keep up the humus content of the soil. Under the high temperature and moist conditions of the wet tropics, the soil loses its organic contents far more rapidly than in temperate regions. The details of cropping have yet to be worked out and the size of the holdings will naturally depend on circumstances such as the locality and soil, size of holdings, and availability of irrigation water. It will be necessary that the peasant should be mainly self-supporting so far as food is concerned. On the other hand, he must be able to grow some crops for sale, otherwise he will not have the cash to provide himself with the necessities of life, such as clothing and amenities, nor will he be able to pay his rent and the taxes which are necessary to maintain the governmental and social services.

The class of livestock suited for peasant holdings requires special consideration. The cow is obviously essential, but the type has not yet been finally decided, although a good deal of work has been devoted to livestock in recent years, particularly in Trinidad and Jamaica. In these two Colonies, experiments have been made to grade up local stocks by the use of high-grade dairy breeds of European origin. The Holstein (Friesian) is the breed favoured in Trinidad, and several breeds, including the Channel Island types, in Jamaica. It has been found that the introduction of European breeds has tended to produce a type that is not really suited to the tropics, as, quite apart from the question of resistance to disease, the respiratory organs are not suited to the heat of the tropics. Efforts to improve matters in these respects are now in progress, using Zebu blood, and undoubtedly considerable progress has been made in producing superior milking cattle. The movement to establish dairies for the production of good milk for supply to the towns has increased of late years and cows bred for this purpose are supplying the gap. Under dairy conditions, however, the cows receive every care and skilled attention and a lot of supplementary and high-grade foodstuffs. Under peasant conditions, such will not be the case, and the cow will have to forage for itself, its food being supplemented with fodder crops and surplus waste from the peasant's holding. The peasant is not likely to be in a position to buy hard grain or cake from outside sources. It is difficult to imagine, therefore, that the large-framed cattle bred for dairy purposes will prove really suitable for the peasant, and one would like to see attempts made to solve the problem by careful selection from the common cows of the countryside.

It is true that there are no indigenous cattle in the country, but they were introduced several hundred years ago by the Spaniards, and running all through the islands one comes across small, shapely beasts, somewhat resembling some of the Channel Island breeds, which are thoroughly hardy and acclimatized and might prove the basis of such a breeding herd as is contemplated. Finally, there is the buffalo. It has been introduced into Trinidad on the sugar estates, but is used solely as a draught beast. Its value as a milch animal is not appreciated, yet in India and the East the buffalo cow is regarded as a fine milking beast and is highly prized as such. In the Colonies with large populations of East Indian descent at any rate, there would appear to be a reasonable prospect for its utilization as a milk-producer.

The details for the consummation of this programme of agricultural reform are now being worked out by the recently appointed Inspector-General of Agriculture, working within the organization set up by the Comptroller for Development and Welfare in the West Indies. The task is immense and one of the difficulties lies in the great variety of climate, soil and conditions that occurs in the various colonies. Each one differs from its neighbours to a remarkable degree, and each has its own peculiar problems. The difficulty of providing staff adequate to tackle the problems involved is enhanced by the number and often the small size of the units concerned. The larger Colonies, such as Jamaica, Trinidad and British Guiana, are in a position to maintain agricultural departments adequately staffed, but the smaller islands cannot afford this, and means will have to be found to pool their resources, and to provide the Inspector General of Agriculture with the necessary staff to carry out essential field experiments, to work out systems of cropping, demonstrate the results of research activities, teach the elements of animal husbandry, and arrange for the orderly marketing of the crops produced.

Many of the problems call for research in the first instance, and up to the present their investigation has not always proved possible. Research work is, in future, to be centralized at the Imperial College of Tropical Agriculture in Trinidad. This institution, after a life of some twenty years only, has already established for itself an enviable reputation and is regarded as the centre for agricultural knowledge, not only by the British Colonies, but also by the Latin American Republics that border the Caribbean Sea, and it has in addition strong cultural ties with the United States and Canada. Already its hands are full, for in addition to a heavy programme of long-range research, it is the centre at which agricultural cadets receive their training for work in the agricultural departments right through the tropical Colonies of the British Empire. The College also trains men for agricultural work in the West Indian area. If it is to be charged with a number of specific West Indian problems in addition, it will need a good deal more financial support, and will have to be expanded. It is undoubtedly the best place at which to carry out the contemplated researches, and, given adequate funds and the necessary increase in staff, there is no reason to doubt that it will fulfil its task.

The West Indies appear to be on the verge of great new developments. The traditional economic system which depended on the production of export crops and the import of food needs modification. Efforts must be made to render these Colonies far more self-supporting in their food requirements than has been the case in the past, for it is believed that a country which is self-supporting in food is far better able to tide over the periodic trade depressions which inevitably occur, since during such periods the export crops may have to be sold at prices far below cost of production or difficulty may even be felt in disposing of them at all. In either case, there is little enough money available to purchase even the bare necessities of life. So, the next few years may see a radical change in the West Indies in the direction of a more rational system of agriculture, having as its main object the better utilization of the land and the preservation of the all-important soil. The policy of settling people on small holdings will be accelerated with the main object of making these Colonies more self-supporting as regards food. In order to effect this, some of the estates which are redundant, or cannot be worked profitably as plantations under existing economic conditions, will have to be taken over and settled with small holders. This does not necessarily mean that the plantation system as a whole with disappear. Many of those which are favourably situated, such as the sugar estates in the larger islands, must continue, and should benefit because the change should result in a more assured supply of labour from a settled peasantry. In fact, a combination of the two systems, each lending support to the other and with interlocking interests, would seem to be the happiest augury for the future.

CARL VON LINDE

A Pioneer of 'Deep' Refrigeration

By J. H. AWBERY
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CARL VON LINDE is probably known to most scientific workers as the designer of a liquid-air machine, and nothing else. He contributed, however, to ordinary refrigeration as well, and still more to the problems of gas separation which are now becoming of such technical importance. Thus it is fitting, in this year which sees the centenary of his birth—he was born on June 11, 1842—to survey his work and to realize the debt which we owe to him.

It was in 1876, when he was thirty-four years of age and professor of thermodynamics at Munich, that Linde took out his patent for an ammonia refrigerating machine. Before this, machines using ether had been used (they are now obsolete), as well as bulky and inefficient cold-air machines; but Linde had the scientific knowledge to calculate the thermodynamic efficiency attainable with different media, and the technical skill to design the plant well—so much so that Ewing, writing in 1908, was able to say: "The design of the Linde machine has been carried out with conspicuous care, and it owes much of its great success to excellence in mechanical detail". From the time of its introduction until recent years, the ammonia machine has been the most widely used refrigerating plant for all purposes except marine work, where carbon dioxide (which also was introduced by Linde, though independently by others) was preferred for various reasons. In recent years, the advent of the turbo-compressor has led to the use of organic refrigerants for air-conditioning work. The wide demand for small domestic plants has also been associated with the use of organic liquids, so that ammonia, though still widely used, is less dominant than formerly.

When he began to work on the production of liquid air, Linde had a clear idea of using it to produce oxygen by fractional distillation, and probably saw this as more important than the attainment of very low temperatures. At the time, air had already been liquefied by various investigators using a number of methods. Linde, in 1893, used a process not unlike that of the ordinary refrigerating plant, but with a heat interchanger to make the cooling cumulative. The air to be liquefied is compressed to a high pressure, cooled by circulating water, and then expanded through a throttle valve. (It is at this point that the process used by Claude differs. In Claude's arrangement, the gas expands in a cylinder and is made to do work so that the process is nearly adiabatic.) Here the temperature falls owing to the unresisted expansion. The cooled air leaving the valve then passes away up the outside of the pipe along which the air flows to the valve; thus the following air starts its expansion at a lower temperature. In this way, the air leaves the valve at continuously lower temperatures, until at last the boiling point is reached, and some of the air liquefies. From this time on, a steady state is approximately reached, in which part of the air leaving the valve flows away in the gaseous form, and may be regarded as the refrigerant, which completes its thermodynamic cycle by warming up to atmospheric temperature, while the remainder is liquefied.

The details of the process have, of course, been modified, but in principle Linde's first apparatus has been closely followed in subsequent design, and has been the basis, not only of liquid-air plants on a large scale, but also of plants for the liquefaction of hydrogen.

One of the two main deviations from the simple process outlined above consists in avoiding the waste which results from the expansion of all the air from high pressure to atmospheric. Actually, it is only that part of the air which is to be drawn off that need be lowered to atmospheric pressure. The remainder, which acts as the refrigerant, can be kept at a much higher pressure, thus greatly reducing the work of compression. To this end, the air at about 200 atmospheres is expanded to 40 atmospheres, and only that part which is to be drawn off is afterwards expanded to atmospheric pressure. It is found in practice that this increases the amount of liquid air obtainable for a given input of energy by about 10 per cent.

The other economy is to cool the air, before compression, by means of a subsidiary (ammonia) refrigerating plant. When the two modifications are used together, the efficiency is raised from about 0·1 gallon per kwh. to 0·3 gallon per kwh.

As mentioned above, Linde undertook the design of a liquid-air plant originally with the idea of using it to extract oxygen from the air, as an improvement on the chemical method then in use. His first really successful apparatus was described in 1902, and utilized the principle of the familiar rectifying column. This depends for its action on the facts that liquid and vapour in equilibrium with each other have different compositions, and that the boiling point of oxygen is higher than that of nitrogen. Thus a liquid with 20 per cent nitrogen and 80 per cent oxygen is in equilibrium with a vapour containing 52 per cent nitrogen and 48 per cent oxygen, while liquid with 80 per cent nitrogen and 20 per cent oxygen corresponds to a vapour with 95 per cent nitrogen and only 5 per cent oxygen.

In a simple rectifier for the production of oxygen, the liquid air, at a temperature just below its boiling point, enters the top of the column, consisting of a chamber stacked with glass balls, over which it trickles to the bottom. The liquid in the column meets a rising stream of oxygen, which is itself cooled and condensed, thereby giving up heat which evaporates nitrogen from the down-flowing liquid. The latter thus becomes progressively richer in oxygen, until at the bottom it consists of nearly pure oxygen. Arrangements are made to draw off the gas from the liquid which collects at the bottom. In its path, it is used to cool the incoming air, and similarly the nitrogen which escapes from the top of the column is made to act as a cooling medium before it finally escapes. By the nature of the process, if pure oxygen is required, the escaping nitrogen is far from pure; conversely, if the rectifier is operated so as to obtain pure nitrogen, then the oxygen is impure. To obtain both elements pure would require multiple rectification, in which the products from both ends were separately redistilled, and it is not at present commercial practice to make both gases in one plant.

It should be noted that the operation of a rectifying column so as to produce pure nitrogen involves appreciable modification. Instead of collecting the desired product as a liquid at the bottom, and allowing some to evaporate, it is then necessary to collect the gas at the top and to condense some of it to provide a downflow of the liquid. The device suitable for this purpose was introduced by Linde some eight years after his first rectifier, and is described as the Linde double-column rectifier.

In the early days of this subject, the only product of commercial importance was oxygen, which is now used (for example, in welding) on an enormous scale. In the last twenty years, however, the demand for nitrogen has become equally important, in view of its use in synthesizing ammonia. When it is required for this purpose, the plant which liquefies and rectifies the air is invariably on the site of the synthetic ammonia works, and the nitrogen merely flows along a pipe line from the rectifier to the point where it is used. Nitrogen of purity 99·96 per cent is now manufactured commercially, without the necessity for any chemical treatment.

This development would have astonished Linde, to whom the nitrogen was not only a troublesome impurity, but the more so on account of its being present to the extent of four fifths of the whole raw material. His astonishment at the rise of nitrogen to an importance such that the two gases are now prepared in roughly equal quantities, would be small compared with his amazement if he could learn that some air is now liquefied for the sole purpose of extracting argon from it, and that there is every likelihood of a thriving industry growing up to extract krypton and xenon—gases which are present in the atmosphere to the extent of 1·1 and 0·08 parts in a million by volume.

Up to the present, the demand for argon arises solely from the needs of the gas-filled lamp, where its high molecular weight makes it of value in preventing the evaporation of the filament, and thus enables the latter to run at a high temperature and a correspondingly high luminous efficiency. Although the gas-filled lamp was only introduced about twenty years ago, its importance may be gauged from the fact that some thousand million such lamps are now made annually.

To separate argon from air, the latter is first fractionated into two components, an argon-oxygen mixture free from nitrogen and an impure nitrogen, which is rejected. The mixture of argon and oxygen is then rectified, by apparatus of the same type as that used in simple rectification; the argon so produced contains the residual nitrogen from the oxygen-argon mixture, the oxygen being practically free from nitrogen and containing about 0·2 per cent argon. The oxygen, of course, is not wasted; it is in fact an economic necessity to obtain a second product when the necessary large volumes of air are being treated to extract the 1 per cent argon which they contain.

Helium and neon have boiling points far below those of argon, oxygen and nitrogen. Hence they remain in the gaseous form, and accumulate at the top of the separating column. It is in some works found profitable to collect these gases from time to time, since neon is, or was until the black-out, in demand as a filling for the gas discharge tubes of striking red colour widely used for advertising purposes.

It is clear from what has been said above that Linde was one of those pioneers whose work was so well done that it could bear extension in many directions: for many of the later developments, carried out since his death, have retained his methods with only minor modifications.

OBITUARIES

Sir Joseph Larmor, F.R.S.

JOSEPH LARMOR was born at Magheragall, Co. Antrim, on July 11, 1857. In his schooldays at the Royal Belfast Academical Institution, he is described as a "thin and delicate black-haired boy of most precocious ability both in mathematics and classics". He gained a scholarship at Queen's College, Belfast, where he graduated with the highest honours. From there he proceeded to St. John's College, Cambridge. A severe illness made it necessary for him to lose a year; but he took the Mathematical Tripos in 1880 and came out Senior Wrangler, J. J. Thomson being second. Larmor was at once appointed professor of natural philosophy in Queen's College, Galway. He was there during 1880–85, and then returned to St. John's College as lecturer. In 1903 the Lucasian professorship fell vacant through the death of Sir George Stokes; Larmor succeeded him, and held the famous chair of Newton until his retirement in 1932. His last years were spent at Holywood, Co. Down, where he died on May 19.

The researches by which Larmor will chiefly be remembered belong to the years about 1895–1905, which are now looked upon as a transition period. The great wave of expansion of physical science in mid-Victorian times, in which Maxwell, Kelvin, Stokes, Rayleigh and others were prominent, had spent its force. Apart from one or two 'small clouds on the horizon', the classical theories seemed to have been well rounded off; and it was beginning to be said that the possibilities of progress were approaching exhaustion. Later the new conceptions associated with quantum theory and the theory of relativity were to arise, and wake theoretical physics into another outbreak of feverish progress. In the interim, two names stand out prominently, Lorentz and Larmor. Their work has not been effaced by the newer developments. Larmor's results are accepted as fundamentally sound, and are now turned to account in ways which must have greatly perturbed the conservative mind of their originator. The magnitude of his achievement was recognized by the award of the Copley Medal of the Royal Society in 1921.

Of the two rivals in the Tripos of 1880, Thomson was the first to achieve wider eminence, originally as a theoretical physicist but later in experimental researches. Larmor, who always remained on the theoretical side, developed more slowly, and it was not until 1892 that his work gained him election into the Royal Society. From 1894 until 1897 he published a notable series of memoirs on electromagnetic theory in the *Philosophical Transactions*; these form the foundation of his book "Aether and Matter", published in 1900. The purpose was to work out systematically the idea, then gaining ground, that matter is essentially an electrical structure. In particular, the continuous electric fluid of Maxwell was replaced by a particle theory which recognized that electricity, like matter, is atomic in structure. A particle theory of electricity was very much in keeping with the experimental advances of the time, but that seems to have been partly a coincidence. The electron was not discovered experimentally until 1897. In "Aether and Matter" the term electron is used indiscriminately for positive and negative charges, although it was not until twelve years later that this view of the nature of positive electricity became reconciled with experimental knowledge.

"Aether and Matter" is, in substance, one of the greatest of scientific books. It is a difficult book, because Larmor's habitual obscurity of style often makes his published work almost as unreadable as his handwriting. But to the student of the period 1900–5 it was the one gateway to new thought, inspiring and revolutionary. It must not be inferred from the title that it represents a wholly antiquated form of thought. Scientific writers nowadays have to bow to the prejudice which does not allow the ether to be named, and are obliged to use a periphrasis; but the 'resonators' and the 'particles in negative energy levels', now employed to fill the space where the ether used to be, expose the error of those who thought the ether had become unnecessary. Modern progress has modified Larmor's "Aether" no more and no less than Larmor's "Matter".

Of special interest was Larmor's result that, if matter is electrically constituted, any moving object must suffer a minute contraction in the direction of its line of motion. The first suggestion of such a contraction was a brilliant guess proposed by FitzGerald to explain the unexpected result of the Michelson-Morley experiment. In the light of Larmor's theory it becomes no longer a hotly disputed hypothesis, but an immediate deduction from the electromagnetic laws universally accepted. In this and in other developments it is difficult to disentangle the shares of Larmor and Lorentz; and perhaps it is of no great moment to separate contributions which have now become woven together. But, from the account given in Whittaker's "History of the Theories of Aether and Electricity", it appears that the well-known Lorentz transformation was originally given by Lorentz in the form of a first-order approximation, afterwards extended by Larmor to the second order, and finally shown by Lorentz to be exact. Since it is in the second order approximation that the contraction effect is found, it was Larmor's contribution which elucidated it; and we shall perhaps do justice between Holland and Ireland if we speak of the "Lorentz transformation" and the "FitzGerald-Larmor" contraction.

Among Larmor's outstanding contributions were two results continually quoted and used in present-day researches, namely his formula for the radiation of energy by an accelerated electron, and his theory of the precession of electron orbits in a magnetic field. He wrote valuable papers on a variety of subjects including hydrodynamics, waves and the Heaviside layer. He was an enthusiast for the Principle of Least Action as the key-stone of physics, and wrote extensively on the transformation of electrodynamics and other branches of physics into that form.

After his own revolutionary outbreak, Larmor became decidedly conservative in his scientific views. It was difficult to ascertain how much he appreciated the new developments in relativity theory and quantum theory, because he was accustomed to adopt a pose which exaggerated his aloofness. In examining dissertations with him one had always to listen to a tirade against the wild kind of problem on which the modern young man spends his time; but he was generally well informed on the actual subject-matter. My impression is that he followed the new theories very attentively, but always cherished the hope of finding a weak spot in them.

Although his heart was with the physicist of the nineteenth century, Larmor must be counted as the harbinger in England of the new ideas which mark the present century. He was the first to throw off the obsession which possessed an earlier generation—that everything must be explained as though the universe had been made from materials and contrivances similar to those of an engineering workshop. The ether of "Aether and Matter" (a development of MacCullagh's rotationally elastic ether) was not a material fluid possessing density, compressibility or other characteristics of gross matter; it was an entity of a different order with properties describable symbolically, in which the "freely mobile intrinsic strains" were shown to give birth to the commonly recognized properties of matter. It was tempting, after his conservative outbursts, to chaff him as having been the moving spirit in the revolutionary ideas which so much disturbed him—and it is undoubtedly true that his teaching had had great influence in that direction—but it was plain that he did not like the accusation.

Larmor had a strong attachment to his native country. It is no coincidence that "Aether and Matter" is so largely a development of the work of his countrymen MacCullagh, Hamilton and FitzGerald. It was probably his intense feeling over the Irish question which persuaded him to enter Parliament, where he represented the University of Cambridge as a Unionist from 1911 until 1922. He can scarcely have found the position congenial; and it was clearly not the right field for his abilities. His most important work outside the University was as secretary of the Royal Society from 1901 until 1912. As a University teacher, his lectures were obscure, ill-ordered and difficult to follow; but they were well worth the effort to follow. There are doubtless many who can, like the writer, testify to the inspiration which they imparted.

A. S. EDDINGTON.

WE regret to announce the following deaths:

Dr. H. A. Des Vœux, president of the National Smoke Abatement Society, on May 20.

Prof. A. R. Forsyth, F.R.S., emeritus professor of mathematics at the Imperial College of Science and Technology, on June 2, aged eighty-three.

Dr. Emil von Grósz, honorary fellow of the Royal Society of Medicine and president of the International Campaign against Tuberculosis, aged seventy-six.

Dr. John Lindsay, professor of physiology and histology at the Glasgow Veterinary College, aged seventy-seven.

Mr. E. Hesketh, a well-known refrigeration engineer, on May 18.

Mr. R. G. McConnell, director of the Geological Survey of Canada and Deputy Minister of Mines during 1914–20, on April 1, aged eighty-five.

NEWS and VIEWS

National Institute for Medical Research

Sir Henry Dale, P.R.S.

SIR HENRY DALE, who retires from the post of director of the National Institute for Medical Research on September 30, has long been the central figure in some of the most active fields of physiological and pharmacological research. During the years 1906–14, he was director of the Wellcome Physiological Research Laboratories, where he gathered around him a very brilliant team of workers. He then joined the staff of the newly formed Medical Research Committee, which became the Medical Research Council in 1920. He has been the effective head of the Council's laboratories at the National Institute at Hampstead since they were first opened. Under his leadership these laboratories have become world-famous.

Much of Dale's early work centred around the pharmacological analysis of extracts of ergot, which were found to contain, among other things, ergotoxine, tyramine, histamine and acetylcholine, all of which had interesting properties and all of which served as the origins of broadening advances. With various collaborators he showed that histamine and acetylcholine are both normal constituents of the body of mammals, and he has done more than any-one else to establish the significance of these discoveries. The work which demonstrated the relation between acetylcholine and nerve endings won the Nobel Prize for Physiology in 1936, which he shared with Otto Loewi. Many other fields of work have been illuminated by his clear brain and genius for experiment, which have done great service to British medical research not only through his own work and that of his immediate colleagues, but also through advice and help freely given to a very large number of people. He has mainly been responsible for the success of the League of Nations in establishing international standards for the biological standardization of bacteriological products, hormones and vitamins, and a large proportion of the actual international standards are kept at the National Institute.

Prof. C. R. Harington, F.R.S.

PROF. C. R. HARINGTON, professor of chemical pathology in the University of London, and director of the Graham Research Laboratories at University College Hospital Medical School, who is to succeed Sir Henry Dale as director of the National Institute for Medical Research, became well known through his work on the active principle of the thyroid gland, which he started with Prof. George Barger in Edinburgh and continued in University College, London. Thyroxine had been isolated by E. C. Kendall but not in sufficient quantities for accurate chemical work. With various collaborators Harington devised an improved method of isolation, determined its structure, synthesized it, resolved it into its optical isomers, showed that the natural isomer was lævo-rotatory, synthesized a number of allied substances some of which had similar pharmacological actions, isolated from the thyroid gland a simple polypeptide which differed from thyroxine in its absorption from the intestine, and showed that di-iodotyrosine was also present in the thyroid. These different aspects of work on a new active principle are generally shared among many different laboratories, and it is remarkable that one man could do so much.

Later, Harington and his colleagues did important work on crystalline insulin and synthesized glutathione. Recently they have been working on the preparation of antibodies which counteract the effects of substances such as thyroxine and aspirin, by combining these comparatively simple substances with proteins and using the compounds thus formed as antigens. Prof. Harington was appointed a member of the Medical Research Council in 1938; he has been editor of the *Biochemical Journal* for some years. His outstanding qualities certainly justify the Council in appointing, as the director of its laboratories, a man who happens to have no medical degree.

Award of James Watt International Medal

THE Council of the Institution of Mechanical Engineers has unanimously awarded the James Watt International Medal to Mr. A. G. M. Michell, of Melbourne, on the nomination of the Institution of Engineers, Australia, the South African Institution of Engineers, and the Engineering Institute of Canada. The Medal was founded by the Institution in 1936 to commemorate the bicentenary of the birth of James Watt on January 19, 1736, and is awarded every two years to an engineer of any nationality who is deemed worthy of the highest award that the Institution can bestow and that a mechanical engineer can receive. In making the award the Institution has secured the co-operation of the leading mechanical engineering institutions and societies in all parts of the world. Mr. Michell, who was elected a fellow of the Royal Society in 1934, is best known for his work in connexion with thrust and journal bearings, but he has, in addition, made a number of extremely valuable contributions to the science of engineering in connexion with centrifugal pumps and crankless engines. His outstanding achievements as a man of science, a mathematician of international fame, an inventor, and a producer fulfil in a unique way the conditions of the award of the Medal. Without the Michell bearing the high-powered modern ship and the large central power station would scarcely have been possible to-day; and, it is, therefore, most appropriate that the Institution of Mechanical Engineers, which is so largely concerned in the development and application of power, should have recognized the pioneer work of Michell by awarding him this Medal. The last award of the Medal was made to an eminent Continental engineer, Prof. Aurel Stodola, who was associated with the development of the scientific basis of the design of steam turbines.

Carl von Linde, 1842—1934

CARL VON LINDE, the centenary of whose birth falls on June 11, and whose work on refrigeration is the subject of an article by Mr. J. H. Awbery elsewhere in this issue (p. 630), was one of the outstanding German engineers of his time. A lecturer of distinction, he was also a successful inventor, a sound constructor, and an indefatigable investigator. Born at Bernsdorf, Oberfranken, Bavaria, he was the son of a pastor, being the third child in a family of nine. His early training had much to do with his success, and in one of his writings he pays a touching tribute to his mother. From school at Kempen he was able to enter Zurich Polytechnic and there came under the influence of the remarkable trio Zeuner, Reuleaux and Clausius. The lectures of Clausius on heat greatly influenced him. From Zurich he entered Borsig's locomotive works at Berlin, and then joined Krauss's new works at Munich. In 1867 he drove Krauss's first locomotive to the World Exhibition at Paris. Soon after this he became an assistant professor at Munich Technical High School, and it was there that he first turned his attention to refrigeration, publishing in 1871 a paper on "Improved Ice- and Refrigerating Machines". The first machines built to his designs were constructed at the famous Maschinenfabrik-Augsburg, which afterwards built the first Diesel engines and has recently been in the news. On April 5, 1876, he took out his patent for an ammonia machine. His work proved so valuable to the brewing industries that in 1879 he resigned his professorship and founded at Wiesbaden the Gesellschaft für Lindes Eismachinen. A.-G., a concern dealing with the planning and design of refrigerating installations.

By 1891 Linde's success was such that he was able to resume his experimental work, establishing for this purpose a research institute at Munich. In 1895 he produced liquid air on a scale hitherto unknown, and in 1902 he erected the first oxygen works. The company founded in 1879 led to Linde machines being made in many countries. In 1901 a gas liquefaction works was opened at Höllsriegelskreuth near Munich, in 1920 a factory for pumps and compressors was started, at Sürth near Cologne and another branch was opened at Mainz. An energetic member of the Verein deutscher Ingenieure, in 1897 Linde was awarded its highest distinction, the Grashof Medal. He was especially interested in Oskar von Miller's work in founding the Deutsches Museum at Munich, and some of his original apparatus is preserved there. He lived to the great age to ninety-two, passing away at Munich on November 16, 1934. His portrait is reproduced in Matschoss's "Great Engineers" (1939).

Physicists during and after the War

IN his address delivered at the annual general meeting of the Institute of Physics in London on May 28, the president, Sir Lawrence Bragg, spoke of the vital part physicists are playing in the national effort and referred to some of the many interesting applications of the science that have been brought to fruition under the stress of the War. The main part of his address was, however, concerned with the future, and his proposals were based on the assumption that mankind is at present in the throes of one of the great mutations of history. He believes that the oncoming technological age will require many scientific workers to continue as technologists into which they have had to turn themselves in these war years, and he suggested that the present training of physicists will need considerable modification to produce more men suitable for this type of work. Anyone who has had experience as an internal examiner is familiar with the type of graduate who knows all about the constitution of the atom but cannot read a vernier scale or perform simple exercises in mensuration. "Industry", he said, "wants physicists who have some idea how thick a piece of copper wire has to be to carry a hundred amperes."

The Planning Committee of the Institute of Physics, of which Sir Lawrence is chairman, is examining the whole question of the training of physicists after the War, although rightly, at present, many of its meetings were concerned rather with the present training and supply of physicists. Having in mind the Government's declared policy of devoting attention to post-war planning and especially to that part concerned with our export trade, the Board of the Institute has instructed the Planning Committee to examine the position of physicists after the War. A memorandum on training has, therefore, been prepared with the view of provoking open discussion, and copies of it will be available to non-members of the Institute on request. Sir Lawrence urged the constant interchange of physics students and staff from the universities with corresponding personnel from industrial and Government laboratories and made some concrete suggestions for the realization of this project. The Institute of Physics in co-operation with other scientific and engineering institutions has certain of these and similar proposals under examination. Physics will have to play an ever-increasing part in both our old-established and newer industries if they are to be enabled to compete fairly in the world's markets after the War. The Institute must, therefore, give the lead in seeing that Great Britain has a sufficient number of adequately trained and able physicists to meet the requirements of industrial and Government undertakings.

A Liquefaction Plant for Natural Gas

The city of Cleveland, on the south shore of Lake Erie, has a population of more than 1,200,000. For domestic purposes and many industries, natural gas is supplied by the East Ohio Gas Co., the gas being brought to Cleveland through four pipe-lines from Hastings, West Virginia, about 150 miles distant. In the early part of each year, short spells of extremely cold weather are experienced, and during these spells there is a great increase in gas consumption. To meet these exceptional demands a liquefaction and storage plant has been erected possessing many interesting features. A description of the plant and a diagram of the processes involved are given in the *Engineer* of May 22. The natural gas is first freed from moisture, carbon dioxide and nitrogen, and then by means of refrigerators the gas is liquefied and its temperature reduced to −258° F., at which temperature it is stored in three insulated spherical tanks under a pressure of 10 lb. A tank consists of an inner sphere of stainless steel 54 ft. in diameter, and an outer sphere of mild steel 60 ft. in diameter. The intervening space is filled with cork through which dried gases are passed to absorb moisture. The total amount of liquid gas stored in the three tanks is equal to the amount of free gas which could be contained in fifty ordinary gas holders each having a capacity of 3,000,000 cub. ft.

Institute of Physics

The annual report of the Board of the Institute of Physics which was adopted at the general meeting held on May 28 records the continued growth in numbers and activities of the Institute. One of the features of the year was the formation of the Industrial Radiology Group—the first subject Group to be formed—under the auspices of the Institute. This step has already been followed by the formation of an Electronics Group. The following were elected to take office on October 1, 1942: *President*, Sir Lawrence Bragg; *Vice-Presidents*, Dr. W. Makower and Mr. T. Smith; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. J. A. Crowther; *Ordinary Members of the Board*, Prof. J. Chadwick, Prof. J. D. Cockcroft, Mr. D. C. Gall and Mr. E. B. Wedmore.

Newton Tercentenary Celebrations

The Royal Society will, if circumstances permit, celebrate, at its anniversary meeting on November 30, the tercentenary of the birth of Sir Isaac Newton. The programme, which will be a modest one owing to the War, is to include three lectures, to be delivered in the Society's apartments at Burlington House, Piccadilly, on "Newton and the Science of his Age", by Prof. E. N. da C. Andrade, Quain professor of physics in the University of London; "Newton as an Experimenter" (with demonstrations), by Lord Rayleigh, emeritus professor of physics in the Imperial College of Science and Technology; and "Newton and the Science of To-day", by Sir James Jeans, professor of astronomy in the Royal Institution of Great Britain.

Storage of National Wheatmeal

A report on the problem of the storage qualities of National wheatmeal has been published by the Research Association of British Flour-Millers in *Milling* of May 23. Storage trials were carried out over a period of a year and included not only laboratory experiments but also tests under commercial conditions in mills, bakeries and buffer depots. Moisture content is the most important factor determining storage life: thus at 14, 14½ and 15½ per cent moisture contents, provided the storage conditions are good and a sound wheat grist is used, the wheatmeals will keep in good condition for 9 months, 4–6 months and 2 months respectively. Temperature is a further factor, and whereas at 60° F. a wheatmeal of 15½ per cent moisture remained in good condition for 11 weeks, at 77° F. it kept only for 3–4 weeks. An additional point of importance revealed by the experiments is that National wheat meal is more prone to insect infestation than white flour.

Silver Leaf Disease

Silver leaf is one of the most serious diseases with which fruit growers have to contend, and the Advisory Leaflet No. 246 issued by the Ministry of Agriculture should do much to clear up misunderstandings on the nature of the disease and thereby improve the methods of control. *Stereum purpureum* is a parasitic fungus which attacks the living tissues of the wood by means of wound penetration. It does not occur in the foliage, and the silvering of the leaves is merely a secondary effect of the attack. Discoloration and eventual death of the infected woody parts of the tree occur, followed by the development of fruiting bodies, by means of which the disease is spread. Illustrations of these fructifications are given, for their recognition on dying trees, old stumps or logs is important if adequate control of the disease is to be obtained.

The silvered leaves do not constitute a source from which the disease can spread. Natural recovery is always a possibility in a slightly affected tree, and removal of all silvered branches in the early stages may prevent an extension of the trouble. Branches that have begun to die back, however, must be cut out and burnt early in the summer and no stumps or roots of a dead tree left in the ground. Every effort should be made to prevent and protect natural wounds on the trees, as it is at such surfaces that the parasite gains an entry. Many kinds of fruit trees may be attacked by this disease, but plums are particularly susceptible, though the variety, or the stock on which the variety is grafted, may influence the susceptibility to some extent. A list of the more commonly attacked varieties of plum and apple is given.

Carnegie United Kingdom Trust

The twenty-eighth annual report of the Carnegie United Kingdom Trust (Dumfermline: The Trust) covers the year 1941, and for reasons of economy omits the accounts from the general distribution although they can be obtained on application. Considerations which govern the grant policy of the trustees are detailed in an appendix. The two main policies upon which the Trust is now engaged, operating on a year-to-year basis, are youth service and music. In regard to the former, grants have been offered to local voluntary bodies in aid of capital expenditure on the equipment of clubs for young people, including both the initial equipment of new clubs and the provision of additional equipment for existing ones. Contributions have also been made to the headquarters administration of the National Associations of Boys' Clubs, Girls' Clubs and Young Farmers' Clubs in England and Wales and in Scotland. Publication of the full report on the exploratory work on mixed clubs for young people of both sexes is anticipated early this year. Grants have also been made for the training of potential youth leaders, but the experiment with youth service camps in Oxfordshire has proved unsuccessful and has been discontinued. The Music Education Committee is encouraging the establishment throughout England and Wales of county music committees to co-ordinate all amateur musical activities in the administrative county areas and to foster new developments. The joint Committee for Drama seeks to promote the establishment of county drama committees and the appointment of county drama organizers. Contributions to the Land Settlement Association have been considerably reduced, but grants to the National Council of Social Service have continued at the £5,000 level in 1940–41–42. In addition, a grant of £3000 to the Y.M.C.A. has enabled the Association to continue its scheme of training boys for farm work and placing them in permanent positions on the land; more than six hundred boys were successfully trained and placed during 1941.

New Zealand Earthquakes

ACCORDING to a bulletin just received from the Dominion Observatory, Wellington, twelve strong earthquakes were registered during February 1942 by the thirteen seismographic stations in New Zealand. The interpretation of many of the seismograms was hindered by microseisms, though it is thought that the earthquake of February 17, the preliminary waves from which arrived at Wellington at 04h. 18m. 24s. U.T., had its epicentre in the Coral Sea. A good deal of minor activity, which is expected in New Zealand, was recorded, and many local shocks were reported as having been felt by observers throughout the islands. The highest intensity reached was 6 on the Rossi-Forel scale (ringing of bells, stopping of clocks, breaking of windows, etc.), which occurred on two occasions: on February 21 at 22h. 23·9m. U.T., felt at New Plymouth, and on February 22 at 12h. 18·1m. U.T., felt at Whakatane and Opotiki, and followed by numerous minor shocks.

Earthquakes Registered in Switzerland

FROM October 1, 1941, until January 31, 1942 (bulletins just received from Zurich), fifty strong earthquakes were registered by the seismographs at Chur, Basel, Neuchâtel and Zurich. Some of these earthquakes were local (that is, in Switzerland), and others have been noticed previously in NATURE. Two, which have not been mentioned previously, occurred in Italy. They were on November 10, 1941, with epicentre near Lago di Garda, *eP* being registered at Chur at 03h. 29m. 21·8s. U.T., and on January 2, 1942, with epicentre in the neighbourhood of Trento, *eP* being recorded at Zurich at 09h. 00m. 41·2s. U.T.

Leprosy in Brazil

ACCORDING to the *Journal of the American Medical Association* of April 4 the prevalence of leprosy in Brazil is comparable to that of the U.S.S.R., which has about 170,000 lepers to 170 millions of population. There are now sixteen modern leprosariums, where 15,173 patients were isolated on December 31, 1941. In the State of São Paulo more than 90 per cent of the contagious cases are isolated in six leprosariums, about 2,500 cases are isolated in the State of Minas Gerais and about 1,000 in the State of Para. There are 15 preventoriums where the healthy children of lepers are interned and many more institutions of the kind are being organized. Since 1938 the technique of infiltrations of the lesions through multiple local injections of chaulmoogra oil has been increasingly used with good results. The epidemiology of leprosy in Brazil is now being investigated. About 25 per cent of the cases are of the purely nervous form. The disease is more prevalent in males than in females and in coloured natives than in white Brazilians. The prevalence is also higher in white foreign people and in white foreign-born Brazilians than in white native-born Brazilians.

University College, Exeter: Air-raid Damage

DURING recent air attacks on Exeter, certain parts of University College were damaged. Some damage was done to the Botany Laboratories, the office building and the Handicraft Centre were completely burnt out, considerable damage was done to the new Library and two halls of residence. All the glass-houses, potting sheds, storehouses, etc., on the College estate were destroyed.

Comet Grigg-Skjellerup

A TELEGRAM from Tokyo has been transmitted by Strömgren announcing the discovery of this comet by Kanna Sekituti. Its position on May 9d. 11h. U.T. was R.A. 7h. 10m., Dec. 11° 46′ N. The magnitude is given as 10.

In the "Handbook of the British Astronomical Association", 1942, Mr. F. R. Cripps has provided the elements and an ephemeris for this comet. The position is very close to that given in the "Handbook", and the object can be easily found from the ephemeris without any corrections.

Date	R.A.	Dec.	r	ρ
June 10·0	9h. 48·6m.	+31° 53′·8	0·899	0·370
18	11 02·5	38 12·4	0·944	0·338
26	12 33·3	41 39·1	0·999	0·331
July 4	14 03·7	40 36·7	1·064	0·348
12	15 15·7	36 15·2	1·135	0·388
20	16 07·9	30 42·7	1·210	0·445
28	16 45·6	25 16·2	1·288	0·515

Announcements

AT the anniversary meeting of the Linnean Society of London held on May 28, the following were elected officers for the year 1942–43: *President*, Dr. E. S. Russell; *Treasurer*, Major F. C. Stern; *Deputy Treasurer*, Dr. B. Barnes; *Secretaries*, Mr. I. H. Burkill (botany) and Dr. Malcolm Smith (zoology). The new members of Council are Dr. G. S. Carter, Dr. F. C. Fraser, Mr. C. C. Hentschel, Dr. N. A. Mackintosh and Dr. R. Melville.

THE National Institute of Hygiene, which was recently founded in Paris, will consist of four departments devoted respectively to epidemiology, general hygiene, problems of nutrition and social diseases (cancer, syphilis, tuberculosis and alcoholism). Each department will be provided with laboratories. The institute will be under the authority of the State Secretary for Family and Health. A National Institute for Social Insurance has also been founded in Paris and will be under the authority of the State Secretary of Labour.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Origins of Human Graphic Art

The following incident deserves scientific record, both for its intrinsic interest and for its bearing on the possible origins of human graphic art.

Meng, a young mountain gorilla (*Gorilla g. beringeri*), previously in the Zoological Society's collection at Regent's Park, was kept in a cage with white tiled walls, illuminated by a single powerful electric light. When he stood in a certain position close to the wall, the light cast a well-defined shadow of the animal on to the white surface. I was watching him one day in February 1939, when he was approximately one and a half years old. Seeing his shadow before him at one moment, he stopped, looked at it, and proceeded to trace its outline with his forefinger.

Luckily, there was an independent scientific witness of this act, as I was accompanied by Mr. E. B. Ford of Oxford. He also had noticed the gorilla's action, and agreed that it was clearly deliberate. The animal proceeded to repeat the same action twice more, but then went on with his play.

I later arranged for a small projection lantern to be set up in the cage so that shadows of different shape could be thrown on the wall. However, the gorilla refused to take any interest, and was never seen to repeat the original performance before his death at the age of about three years. I should add that Meng was exceptionally intelligent and docile.

I can find no record in the literature of any anthropoid performing a similar action. It would be of considerable interest if observation and experiment designed to elicit similar behaviour were carried out on other young anthropoids.

Various suggestions have been made as to the origins of human graphic art: for example, scribbling, the incision of geometrical patterns or their tracing in sand or clay, tracing the outline of a hand or other object held against a rock face, as well as deliberate attempts at representation. To these I think we should add the possibility of tracing the shadows cast by a low sun against a more or less vertical cliff or cave-wall.

Julian S. Huxley.

Zoological Society,
Regent's Park,
London, N.W.8.
May 12.

Effect of Ascorbic Acid on the Survival of Traumatized Animals

Clinical observers seem to be generally agreed that there is little relation between the degree of traumatic shock and the severity of the injury by which it is produced. However, the following observations, made during the course of a general study of wound ballistics, suggest that there is a quantitative relation between shock and trauma, even though there may remain some doubt how far the traumatic shock seen in experimental animals is equivalent to the clinical condition of 'shock' observed in man.

The primary purpose of these observations was to relate the degree of trauma, expressed in terms of the energy by which it is caused (all other conditions being kept constant) and the severity of 'shock' as estimated by the mortality-rate in groups of anæsthetized animals traumatized to different degrees. Thus, in a first series of experiments with anæsthetized guinea pigs, it was possible to calculate the amount of energy transmitted to the tissues by the missile by which they were injured. It was found that the amount of energy is related both to the degree of tissue damage and to the mortality-rate.

In a second series of experiments, anæsthetized guinea pigs were traumatized by means of a weight falling from different heights. It was again found that there is a definite relation between the mortality-rate and the amount of transmitted energy. Thus, death practically never occurs when the energy of the blow is less than 2·75 kgm. m. It occurs more frequently at energy levels between 2·8 and 3·4 kgm. m., and appears to be constant at a level of 3·7 kgm. m. Post-mortem examination of the animals used in these experiments showed the typical hæmorrhagic lesions which are stated to be characteristic of shock (Moon, 1938)[1].

If it be assumed that the condition of the animals during the post-traumatic interval is equivalent to that which is clinically recognized as 'shock', these experiments suggest that there is a quantitative relationship between the intensity of shock and the chances of survival on one hand, and the degree of trauma administered on the other. A similar conclusion is suggested by Noble and Collip (1942)[2] in a paper which has just appeared.

A further series of experiments has been carried out in order to test the effect of ascorbic acid on the survival of guinea pigs injured by a falling weight. It was found that animals subjected to the minimum degree of traumatization which otherwise would have caused 100 per cent mortality always survived after the subcutaneous injection of ascorbic acid, in doses above 100 mgm./kgm. body weight. The beneficial effect of the ascorbic acid becomes increasingly less if treatment is delayed after traumatization. Thus, if the injection of ascorbic acid is made after the lapse of an hour, survival occurs in only some 50 per cent of the experimental animals. Following a suggestion by Dr. A. N. Drury, the influence of vitamin B_1, in doses of 5–15 mgm./kgm. body weight, was also tested. This substance was found to be less effective than ascorbic acid, only four of a group of ten traumatized animals given vitamin B_1 surviving.

The way in which ascorbic acid exercises its effect in these circumstances is unknown. Guinea pigs, like man, do not synthesize their own ascorbic acid, but obtain the vitamin from their food. All the guinea pigs used in these experiments were maintained on the same diet, but, since no vitamin C estimations were performed, it is not impossible that some of them were deficient in this factor. Whether or not this was the case, the experiments suggest that the administration of ascorbic acid in doses higher than the normal vitamin requirement has a very marked effect upon survival. The possibility that the effect is due to some pharmacological property not encompassed by the term 'vitamin' was tested in a further set of experiments on rats, which were also traumatized by means of the falling weight technique. As in the case of guinea pigs, it was found that rats which were traumatized at a level of energy-input at which control experiment showed that death would normally ensue, survived if given ascorbic acid, shortly after the trauma, in a concentration of 100 mgm./kgm. body weight. Since rats synthesize their own ascorbic acid and are animals in which, by definition, ascorbic acid is not a vitamin, it is probable that the beneficial effect of the substance after trauma is due to some other pharmacological property, which it possesses.

The above experiments, of which a full account will be published later, are part of a programme of work on wound ballistics carried out under the direction of Dr. S. Zuckerman.

GEORGES UNGAR
(Free French Forces).

Department of Human Anatomy,
Oxford.

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[1] Moon, V., "Shock and Related Capillary Phenomena," Oxford Medical Publications (1938).

[2] Noble, R. L., and Collip, J. B., *Quart. J. Exp. Physiol.*, 31, 187 (1942).

A New Synthesis of X-Ray Data for Crystal Analysis

RECENTLY considerable discussion has taken place about the use of Patterson vector diagrams in crystal analysis[1]. The difficulties of interpreting these diagrams in the case of complex structures as pointed out in this discussion and particularly emphasized by Sir Lawrence Bragg have led me to develop a more efficient method. This seems to be possible in the following way. Imagine a linear crystal consisting in its unit interval of s dimensionless atoms of atomic number Z_α and parameter x_α ($\alpha = 1, 2, \ldots s$). Then we can define a quantity $E(h)$ deducible directly from X-ray intensity data by

$$E(h) = \sum_{\gamma=0}^{t} g_\gamma \cos 2\pi h u_\gamma, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $g_0 = \frac{1}{2} \sum_{\alpha=1}^{s} Z_\alpha^2$, $g_\gamma = Z_\alpha Z_\beta$, $t = s\,(s-1)$, $u_\gamma =$ $x_\alpha - x_\beta$ or $1 - (x_\alpha - x_\beta)$ according as $x_\alpha - x_\beta <$ or $> \frac{1}{2}$ respectively. My principal idea in the new method is to synthesize the empirically deduced $E(h)$ according to equat. (5) given later in such a way that $E(h)$ is put empirically into the form :

$$E(h) = \sum_{\mu=0}^{N/2} P_\mu \cos 2\pi h u_\mu, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where N is the number of divisions into which the fundamental unit interval of the linear crystal is divided. The possibility of the empirical determination of equat. (2) rests on the discovery of the equation,

$$E(q) = \frac{q \sin \pi q}{\pi} \sum_{h=0}^{\infty} (-1)^h \frac{E_h}{q^2 - h^2}, \quad . \quad . \quad (3)$$

where h is zero or an integer and q any real number; $E_0 = E(0)$, $E_h = 2E(h)$. Equat. (2) is then established by a suitable method of Fourier expansion of $E(q)$ given by equat. (3). The final formula for the calculation of P_μ is,

$$P_\mu = \sum_{h=0}^{\infty} a_{\mu h} E_h, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

in which $a_{\mu h}$'s are constants depending on N and independent of the structure investigated. $a_{\mu h}$ decreases with h so that the right-hand side of equat. (4) is a convergent series. The linear relationship between P_μ and E_h enables P_μ to be computed quickly by a computing machine or by means of strips similar to those devised by Beevers and Lipson[2] for the computation of Fourier summation.

It is to be noted that equations (1) and (2) are of the same form. If N is chosen large enough, equations (1) and (2) would be almost identical term by term. Consequently, a comparison of the empirically determined P_μ with the theoretically calculated g_γ gives us information not only of the numerical values of u_γ but also of which pair of atoms this u_γ is due to. Furthermore, since Z's are known integers, the identification mentioned above is possible even when the values of P_μ determined empirically are not exactly equal to those of g_γ. This may arise from an incorrect choice of N, from the approximation introduced in equat. (5) mentioned below, or from the experimental error within the limit of modern intensity measurement. The choice of N is guided by the accuracy of intensity measurement, the complexity of the structure investigated, and the number of atoms contained in the unit interval. If necessary, the question whether N has been chosen correctly or not can be settled by making various syntheses for different values of N, say, N, $N/2$, $N/4$ to see if some of the equivalent terms in equat. (2) shift or not, or the values of some P_μ suffer a great change. In this way more exact and more definite information can be obtained.

$E(h)$ defined by equat. (1) is deduced from the observed $|F(h)|^2$ values of the actual structure by

$$E(h) = \frac{|F(h)|^2 8}{2\psi(j)^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where $\psi(j)$ is the well-known function involved in the calculation of atomic structure factor f by the Thomas-Fermi method[3]. Numerical values of $\psi(j)$ for j ranging from 0 to $3{\cdot}85\pi$ are available[4]. Equat. (5) is exact if the structure investigated is one of a pure element or an alloy in a disordered arrangement. When the structure contains no comparatively heavy atoms, equat. (5) is still almost exact; otherwise it is true only to a near approximation. But in the last case only those terms in equations (1) and (2) which involve the contributions of the heavy atoms stand out, and therefore an identification of these terms alone is sufficient for an analysis. We thus expect the method to be applicable to all cases.

Finally, we may construct a point diagram in the one-dimensional discontinuous μ space in which every point μ is associated with a corresponding P_μ according to equat. (2). The result is similar to the Patterson vector diagram, with the following differences :

(1) The quantity marked on the diagram is $Z_\alpha Z_\beta$. Thus the nature of the vectors is known at once.

(2) The diagram is a point diagram so that there is, theoretically speaking, no fear of interference of peaks provided the unit interval is finely divided. If superposition between peaks takes place, this superposition will be known directly from the comparison $P_\mu = g_\gamma$; otherwise the peaks should remain distinct from each other, no matter how close they crowd together. The last statement means that the method is applicable to complex as well as simple structures. The sharpening of peaks is partially successful in the modified Patterson method[5]. But

there the gain in resolving power is at the expense of the truthfulness of the background of the diagram by the introduction of undesirable spurious peaks.

(3) Since the series in equation (4) is convergent, it can be cut off at a suitable high order term without appreciable effect on the calculated values of P_μ. Thus, in contrast with all the Fourier methods, the so-called diffraction effects should be theoretically inappreciable in the new method.

In view of these significant improvements, we conclude that the new synthesis will be able to derive more useful information directly from the observed data than the classical Patterson, and so further narrow down the choice of alternative structures in an actual analysis.

I cannot enter here into many points which are essential for the complete understanding of the method. A detailed account, including the extension to two and three dimensions and the generalization of the method to other classical Fourier methods, will be given elsewhere. The calculation of $a_{\mu h}$'s of a two-dimensional synthesis for $N = 100$ is being undertaken. As a preliminary study and as an illustration, the method has been applied to the analysis of the simple known structure of iron pyrites. The result has been briefly described in *Science Records*[6].

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Kunming.
Feb. 22.

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[1] Wrinch, NATURE, 142, 955 (1938); Bragg, W. L., NATURE, 143, 74 (1939); Bernal, NATURE, 143, 75 (1939); Robertson, NATURE, 143, 75 (1939).

[2] Beevers and Lipson, *Phil. Mag.*, 17, 855 (1934).

[3] Bragg, W. L., and West, *Z. Krist.*, 69, 118 (1929); Debye, *Phys. Z.*, 31, 419 (1930); Woo, *Tsing-Hua Science Reports*, 1, 55 (1931).

[4] Yü, *Tsing-Hua Science Reports*, 1, 155 (1932).

[5] Patterson, *Z. Krist.*, 90, 517 (1935).

[6] Yü and Ho, *Science Records, Academia Sinica*, 1 (1941).

Enzymatic Production of Bacterial Polysaccharides

SEVERAL investigators have reported the formation of polysaccharide material by sterile filtrates obtained from various species of spore-forming bacilli. Thus in 1910 Beijerinck[1], using 'viscosaccharase', an enzyme present in filtered preparations of *B. mesentericus*, observed the formation of 'slime' on a sucrose-agar medium. In 1930 Harrison *et al.*[2] isolated this enzyme and showed that the 'slime' was a levan. Dienes[3], working with Oerskov's milk-bacillus and with organisms of the *subtilis* group, demonstrated that sterile extracts of these organisms could form from sucrose 'extra-bacterial' granules of a polysaccharide nature. He, too, was probably dealing with a levan-synthesizing enzyme which has now been isolated in an active form from Aerobacter[4].

From *Leuconostoc mesenteroides* Heyre and Sugg[5] isolated in an ingenious manner an enzyme which could synthesize, from sucrose alone, a dextran identical both chemically and serologically with the dextran produced by the living organism. Some time ago in these laboratories we also isolated an extremely active exocellular dextran-synthesizing enzyme from *L. mesenteroides*, but circumstances caused the interruption of the work before our investigations were completed. Inasmuch as we hope to resume the research at some future date we now publish our preliminary results, which initiate a new field of study concerning the symbiosis of yeasts and bacteria.

Our investigations[6] dealt with the search for growth-promoting factors which could stimulate dextran production by Leuconostoc species. We obtained a number of 'slimes' from a beet-sugar factory, and one of these was subjected to bacteriological analysis by Prof. A. J. Kluyver of Delft and was found to contain *L. mesenteroides*, *Saccharomyces cerevisiœ* Hansen and a Streptobacterium, each of which he isolated in pure culture. Since many natural viscous fermentations, such as Kephir and Tibi[7], are due to the symbiotic action of yeasts and bacteria, it occurred to us to grow this strain of *L. mesenteroides* in symbiotic association with *Saccharomyces cerevisiœ*. The growth medium was that described by Stacey and Youd[6] and 5 c.c. quantities were inoculated separately with the yeast and the Leuconostoc and incubated at 30°. After two successive subcultures from the mixed culture there was a remarkable production of dextran, the yield reaching a maximum in forty hours, whereas a period of ten days was required by the *L. mesenteroides* in pure culture to produce its maximum yield. After a third successive subculture it was noted that an opalescence occurred in the medium after one hour, that there was considerable dextran production after four hours, while after ten hours the whole medium formed a gel composed almost entirely of dextran. In the four-hour culture above, microscopic and cultural examination revealed the almost complete absence of both yeasts and bacteria, so that dextran production at this stage was undoubtedly due to exocellular enzymatic action. Confirmation of this was forthcoming from the fact that heavy inoculations from sterile filtrates of twenty-four-hour cultures produced dextran in a few hours on the same sucrose-peptone medium. This production was, however, less dramatic than that obtained by inoculation with an equal amount of unfiltered ten-hour cultures, and there is little doubt that in the latter case the enzyme system was sharply stimulated by a factor elaborated *in situ* by the living yeast cells.

The dextran was of the mucoid type and, after isolation, remained insoluble in water. By the method described by Daker and Stacey[8] it was obtained in a less viscous, water-soluble form, $[\alpha]_D + 180°$ in water, N, 0·5 per cent, and gave only glucose on acid hydrolysis.

The isolation of an enzyme capable of synthesizing a polyglucose having 1 : 6-linkages[9] from sucrose (glucose-1-fructofuranose) would appear to have a significance comparable with Hanes's discovery of the starch-synthesizing enzyme which utilizes glucose 1-phosphate; and further work in this field should lead to an understanding of some of the underlying mechanisms of enzymatic synthesis.

M. STACEY.

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University of Birmingham.
May 14.

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[1] Beijerinck, M. W. K., *Akad. Wetensch.*, Amsterdam, 12, 635 (1910).

[2] Harrison, Tarr, and Hibbert, *Can. J. Res.*, 3, 499 (1930).

[3] Dienes, *J. Infec. Dis.*, 57, 12 (1935).

[4] Aschner *et al.*, NATURE, 149, 527 (1942).

[5] Heyre and Sugg, *J. Exp. Med.*, 75, 339 (1942).

[6] Stacey and Youd, *Biochem. J.*, 32, 1943 (1930).

[7] Mayer, H. D., "Das Tibi-Consortium" (Delft, 1938).

[8] Daker and Stacey, *Biochem. J.*, 32, 1946 (1938).

[9] Peat, Schlüchterer, and Stacey, *J. Chem. Soc.*, 581 (1938).

Simplification of Musical Notation

The value of the scientific method, to which Lord Brabazon appeals, lies in the proper use of experiment. There is available to-day a growing amount of piano music which is written without key signature, because it is without key, and with chromatic notes inserted as required. It is easy to find out whether it has the advantages Lord Brabazon assumes for his tentative proposal to omit key signatures as a first step towards a simpler notation.

For my own part I find this music difficult to read, because I have then to read each note. That may be one reason why such music repels me. But for earlier music, for which staff notation was developed, Lord Brabazon's analogy with the printed book is a good one. Just as one does not read each letter, perhaps not even each word, of a printed sentence (whence the difficulty of proof correction), so in reading music one has no time to read each note. One reads groups of notes.

Such proposed alternatives for staff notation as I have seen do not readily assist this kind of reading. In other words, they hold no promise of standing up to the scientific test, that of the control experiment. Until someone invents a notation that does, which will make music in twelve-tone technique easier to read, and perhaps to understand, musicians will remain hopeful but not expectant.

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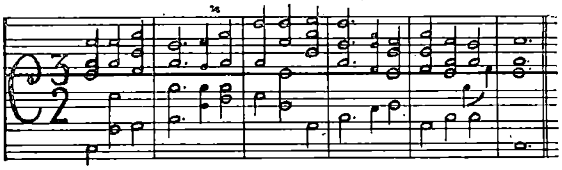
The plea of Lord Brabazon in Nature of May 16, p. 554, will be strongly supported by thousands of would-be players to whom the complications of clefs, key changes and accidentals have proved an impassable barrier, and by the parents of many otherwise musical children who have given up their pianoforte studies in despair because of these difficulties. On the plea of the greatest good for the greatest number, therefore, Lord Brabazon's appeal ought to receive most careful and unbiased consideration, and not least from those musicians whose real desire it is to extend the art of music-making among ordinary people. Furthermore, the use of a special form of stave for the piano and organ would not be so great a departure from tradition as might at first be supposed, for is it not on a par with the provision of special clefs for some of the instruments in the orchestra ? (Incidentally, why must we continue to use an *H* to denote a *C* clef, and a *C* for an *F* clef ?)

As a practical contribution may I put forward a simple solution ? Why not make the appearance of the printed music bear an easily recognized resemblance to the array of black and white keys on the keyboard ? Thus : make the stave consist of horizontal lines in sets of twos and threes, so that the *black lines* correspond to the *black keys*, and the white spaces the white keys. This would do away with the "treble" and "bass" clefs, with their different names for similarly placed symbols, and eliminate all sharps and flats. The three octaves at present included within the compass of the normal treble and bass clefs would naturally occupy a little more space, but the gain in clarity is obvious; every note on the keyboard having its unmistakable and unique position on the printed page.

The following example shows the first six bars of the National Anthem in the key of *A* (3 sharps) written in the new notation*. The 'dot' forming the commencement of the "C" at the beginning of the stave represents the middle *C* of the piano.



The line denoting middle C sharp is purposely made bolder ; this guides the eye and improves clarity.

Leger lines, with similar gaps between the groups of twos and threes, would be employed for notes above and below the stave, but the use of the (8ve) and (16ve) devices is to be strongly recommended wherever possible.

If any music publisher should be sufficiently interested and large-minded to answer Lord Brabazon's plea by preparing to issue a series of graded classical and popular music in some such simplified notation, as soon as war-time restrictions are relaxed, he would earn the gratitude of many now living who are debarred from 'making their own music' by the barbed-wire entanglements of sharps and flats, and would bring into the realm of possibility for future generations an era of 'music without tears'.

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* Since devising this stave I have found that one on similar lines was put forward some 50 or 60 years ago by Mitcherd. Evidently then the times were not propitious !

Luminous Phenomenon Accompanying the Cyprus Earthquake, January 20, 1941

As reported in Nature of February 1 and 8, 1941, an earthquake of intensity VII or VIII on the Forel-Mercalli scale—the severest in Cyprus for the last sixty years—occurred on January 20, 1941, at about 5.35 local time. The beginning, as recorded at Ksara Observatory near Beyrouth, was 3h. 37m. 38s. G.M.T.

The epicentre lies between Cyprus and the Syrian coast, 200 km. from the latter and probably near the south-east coast of Cyprus. This is a region where earthquakes are not very rare.

A bright flash associated with the earthquake was seen from the eastern and central parts of the island. A Nicosia Hodja who was on the minaret for morning prayer, in describing the event, said that he first heard a deafening noise suggesting the impact of a gigantic projectile on the surface of the earth with a simultaneous rocking motion so severe that he feared the minaret would collapse. Afterwards he saw a brilliant reddish object like a huge globular lightning moving slowly towards the east. The tremors then changed into horizontal waves and gradually vanished. There is strong evidence that direction of the flash was pointing to the epicentral area.

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RESEARCH ITEMS

Modern Stone-Age Man in South Australia

AN interesting light is thrown on possible methods used by early man by a recent description of modern stone-age man in the Musgrave Range, South Australia. The Pitjendara tribe is one of the most primitive in Australia, and among their few possessions are spears and spear-throwers fitted with an adze stone on the end. The manufacture of these spear-throwers is the subject of a recent paper "An Unrecorded Method of Manufacturing Wooden Implements by Simple Stone Tools", by C. P. Mountford (*Trans. Roy. Soc. South Aust.*, 65, (2); 1941). The tools selected were natural stones chosen for possible cutting edges, but left undressed. With these as the sole instruments a shaped slab of wood was stripped from a small mulga tree—a slow, laborious process—and the bark removed before being taken to camp. Here the shaping and finishing took place with the help of smaller, but still unflaked, stones, and finally with the aid of the adze stone of a finished spear-thrower. The adze stones themselves were merely flakes of chert with good cutting edges and were stuck into the handle end of the spear-thrower with spinifex gum warmed over the fire. When these stones became blunted with use there were some attempts to create a fresh cutting edge by tapping them with the wooden blade of a spear till miniature flakes were broken off. The throwing peg was made of wood and attached by spinifex gum to the tip of the spear-thrower and then securely bound with tendon. The stones used in these processes were all discarded and left behind, and as such stones bear no recognizable trace of their use by human beings, a material culture such as that of the Pitjendara tribe might well become extinct without leaving any trace of its existence.

Hæmophilia-like Condition in Pigs

HÆMOPHILIA and blood conditions that resemble this abnormality have been known in man for many years. On the other hand, such a condition appears to have remained hitherto undetected among pigs. R. Bogart and M. E. Muhrer have described a hæmophilia-like condition in a line of inbred Poland China pigs (*J. Hered.*, 33, No. 2, 1942.) The feature first becomes evident at about two months in age but is by no means constant in this respect. In general, the abnormality becomes increasingly severe as the animals become older. Like hæmophilia in man, it is due to a thromboplastin deficiency. It appears that this hæmophilia-like condition in pigs is due to a recessive gene and that the variation between different individuals as regards the severity of the abnormality is brought about by modifying genes. The character is not sex-linked as in man but would cause great losses to pig breeders should the gene concerned become widespread. The authors observed the phenomenon in animals used for breeding at the Missouri Agricultural Experiment Station.

Colchicine and the Production of New Types of Forage Crops

UNTIL recently the production of improved varieties of plants has been almost restricted to selection and hybridization within and between closely related species, since intergeneric hybrids show a complete or high degree of sterility. Colchicine affects mitosis, and cells which have an optimum dose of this substance may begin to divide but fail to complete the process, so that the two sets of chromosomes reunite with a consequent doubling of the chromosome number. If this effect can be induced in tissues which will eventually give rise to the gametic tissues, normal pairing of chromosomes occurs at meiosis so that fertility is restored and an amphidiploid type is produced. The difficulty to date has been to devise a method of application of the colchicine which produces sufficient penetration of the tissues without killing the plant. F. H. Peto and G. A. Young (*Canadian J. Res.*, 20, No. 3, Sect. C; 1942) have tested methods of application of colchicine to sterile hybrids of Triticum species with *Agropyron glaucum*. The more effective methods were (1) immersion of the young seedling in 2 per cent colchicine solution and (2) enclosure of the decapitated seedling stem in a capsule containing agar with 0·1 or 0·4 per cent colchicine. The latter method affected the young tillers and proved the most effective; of the surviving plants 21·2 per cent showed fertility, and this treatment also led to less wastage of the valuable hybrid material than methods involving immersion of seedlings or seed in the solution. The application of these methods to Triticum-Agropyron hybrids shows that fertility may readily be induced in the sterile hybrids by doubling of the chromosome number; this opens the possibility of combining the characters of related genera and the production of a vast range of new types of forage crops. One such colchicine-induced fertile amphidiploid, first produced in 1938, is now available in sufficient quantity for extensive field tests, while a number of others will be ready for similar trials in the course of a few years.

Diseases of Miscellaneous Crops

SEVERAL uncommon diseases of seakale, artichoke, sweet corn, asparagus and rhubarb have been briefly described by D. E. Green (*J. Roy. Hort. Soc.*, 67, Pt. 3; March, 1942). Rhubarb is occasionally attacked by the honey fungus, *Armillaria mellea*, in addition to crown rot and grey mould. Seakale may be infected with club-root, black-rot (*Pseudomonas campestris*), soft-rot (*Bacterium carotovorum*) and violet root-rot (*Helicobasidium purpureum*), which also parasitizes chicory, artichoke and asparagus. Grain mould of sweet corn may be caused by several fungi of the genera Penicillium and Fusarium.

Analysis of Certain Foods

AT a meeting of the Society of Public Analysts and Other Analytical Chemists held on May 6, E. T. Illing and E. G. Whittle gave analytical data for samples of soya bean meal and of cereal fillers ('pabs' and bread) and discussed them in relation to the methods used. Starch was determined by several methods: precipitation by alchohol, and precipitation as iodo-compound which in some instances was decomposed and the starch precipitated by alcohol and weighed. Soya meal gave consistently high results by the first method, and moist mixtures of soya meal and bread gave low results by the last one. Methods were suggested for calculating the contents of soya meal, cereal and filler and meat in sausages and the like from the determined percentages of water, fat, protein, starch (by alcoholic precipitation) and salt-free ash. Some observations were made on the microscopic detection of soya.

Gravimetric Micro-determination of Magnesium

THIS method was described by P. F. Holt at a meeting of the Society of Public Analysts and Other Analytical Chemists on May 6. Benedetti-Pichler's method for the gravimetric micro-determination of magnesium, in which the metal is precipitated and weighed as $MgNH_4PO_46H_2O$, was found to give results which varied according to the time allowed for precipitation. Consistent but high results were obtained if the precipitate was allowed to stand in contact with the mother-liquor for several hours. A precipitation time of one hour or less gave values which were irregular but approximated to that calculated from the formula. Good values are obtained by this method if five hours are allowed for precipitation of the magnesium-ammonium salt and an empirical factor is used for conversion of precipitation weight to weight of magnesium.

Quantum Chemistry

THERE is a remarkable identity, due to Dirac, connecting the operators of exchange and spin. Taken in conjunction with the principle that in the problem of several electrons, a wave function must change sign when the orbital and spin co-ordinates are both subjected to the same permutation, the identity shows that any permutation of the orbital variables can be obtained from a certain spin operator. In other words, spin compensation goes with antisymmetry of the spin function. This is known to be fundamental in the quantum explanation of chemical bonds. E. Schrödinger has obtained a generalization of Dirac's identity (*Proc. Roy. Irish Acad.*, 47, 39; 1941). In the generalization, chemical compensation of spin occurs in groups of particles, instead of in pairs of single particles. Something like this applies to the heavy particles (proton-neutrons) in the nucleus. Spin compensation in this case corresponds to unit charge for each two particles. This view is supported by its agreement with several basic results concerning the nucleus.

Frequency Comparisons

L. A. MEACHAM (*Bell Lab. Rec.*, 20, No. 7, March 1942), in an article on high-precision frequency comparisons, describes a test circuit capable of making short time measurements. When measurements must be made within a short period, direct methods fail because the time intervals cannot be determined with sufficient accuracy; but as deviations rather than absolute values are of interest, it is possible to substitute comparisons between the frequencies of two or more similar but independent oscillators. Excellent precision is obtainable by this method with equipment built to check the performance of bridge-stabilized oscillators used in the Bell System frequency standard. The oscillators were designed to be stable within 0·0001 c./sec. and the testing circuit, therefore, had to detect a variation of ten times this amount. Furthermore, the momentary nature of the changes necessitates that the measurements represent nearly instantaneous frequency values and be obtained at very brief intervals. Two 100 kc. oscillators are employed, adjusted to differ in frequency by about 0·1 c./sec. Their outputs are added together in a hybrid coil and the sum amplified and rectified to fire a thyratron tube once each beat cycle, in turn discharging a condenser through a spark coil. The resulting high voltage from the coil causes a brief flash of light in the neck of a mercury vapour lamp. A circular scale marked in milliseconds is rotated by a 1,000-cycle motor synchronized with current from the frequency standard, to record the time between flashes. Each discharge illuminates the scale and records the time on a slowly moving film, so that the time which elapses during a single ten-second beat-cycle is recorded to the nearest thousandth of a second, and any irregularity in the beat frequency amounting to more than one part in ten thousand becomes apparent. As the frequency of the beat pulses is only one millionth of the frequency of either 100 kc. oscillator, the precision of the comparison between the pair of oscillators is approximately one part in ten thousand million (10^{10}). An irregularity so small as to be undetectable by any rapid direct method thus produces a very noticeable record in the new measuring device.

Penetrating Cosmic-Ray Showers

Counter experiments on showers penetrating at least 50 cm. of lead are reported by L. Jánossy (*Proc. Roy. Soc.*, A, 179, 361; 1942). It is concluded that these penetrating showers are parts of extensive air showers, are neither energetic cascades nor knock-on showers but are probably connected with the production of mesons. The connexion of the penetrating showers observed at sea-level with the production of mesons in the atmosphere is discussed from the alternate postulates that the mesons are (i) produced by photons and (ii) that they are mainly produced by protons and possibly neutrons.

Movements of Hydrogen Flocculi

M. A. ELLISON has described his investigations on surges near sunspots and quasi-eruptive flocculi in the vicinity of chromospheric eruptions (*Mon. Not. Roy. Astro. Soc.*, 102, 1; 1942). A short account is given of the spectrohelioscope which was used at Sherborne (*J. Brit. Astro. Assoc.*, 50, 107; 1940) but some modifications were introduced for the present investigation. Ellison has kept a special watch for surges since 1940 and has found that they are the most frequent of all prominence types, though they are the most short-lived of chromospheric phenomena. Radial velocity - time curves are shown in diagrams and a table includes various details regarding position, times of beginning and ending, etc. Distance integrals and accelerations are deduced and the former are in satisfactory agreement with the heights observed for the limb prominences of corresponding type. In the case of quasi-eruptive flocculi, the Doppler time-curves are of the same general form as those for surges, but the velocities of ascent and descent are greater. In one case the velocity of ascent was found to be a little greater than the value of g on the sun's surface. In the years 1940–41 about five hundred measures of radial velocities were made on active short-lived dark flocculi which occurred in the vicinity of sunspots. A well-defined maximum frequency of descending motions was shown to exist at about 30 km./sec. and of ascending motions at 35 km./sec. These figures are in good agreement with those obtained by H. W. Newton at Greenwich in 1930–33. There is one important difference, however. The Greenwich analysis showed a high percentage of radial velocities in the range 0·9 km./sec., and the Sherborne results did not reveal this. The apparent discrepancy is due to the fact that Ellison sought specially for active flocculi and omitted slow-moving flocculi.

ing glide lamellæ is $2\,AB = 2t.\tan\varphi$, where t is the thickness of the lamellæ, and φ the angle between the glide plane and the normal to the plane of kinking. The condition that this should be an integral multiple of the lattice period a in the direction of glide is

$$2t.\tan\varphi = n.a.$$

This is the same phase relationship as that expressed by Bragg's law in the case of X-ray diffraction; $t/\cos\varphi = d$ is the spacing of the glide lamellæ in the plane of kinking. It is proposed to check this equation by X-ray measurements of the thickness of the glide lamellæ.

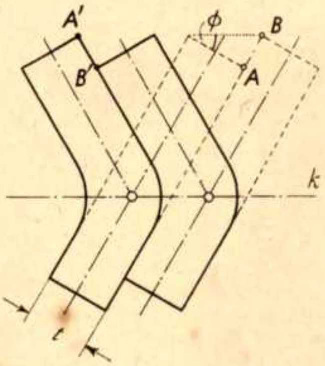

Fig. 4.
AMOUNT OF GLIDE BETWEEN NEIGHBOURING GLIDE LAMELLÆ.

Fig. 5 shows how plastic extension and compression may result from kink bands. In these diagrams the initial position of the glide planes was assumed to make angles of 45° with the stress axis, as is the case, for example, with sodium chloride crystals stressed in the (100) direction. If the angle φ is small, the angle between the kink band and the specimen axis is only slightly less than 45° in compression, and only slightly more than 45° in extension; thus in such cases the kink bands can easily be confused with genuine glide bands. Brilliantow and Obreimow[4] have shown that, in fact, the deformation bands in sodium chloride crystals compressed at room temperature represent not glide bands but what they called "irrational twins" or "big twins". While, for geometrical reasons, twins cannot be "irrational" in the sense used by these authors, it is clear from their description that at room temperature sodium chloride deforms mainly, or entirely, by kinking, and its well-known deformation bands are not glide bands but kink bands. There are many indications[5] that deformation bands in metals hitherto considered glide or twin bands may be, in reality, kink bands; and the possibility must be kept in mind that glide may begin in many or in all cases with kinking. The phenomenon of jerky extension[6] points in this direction.

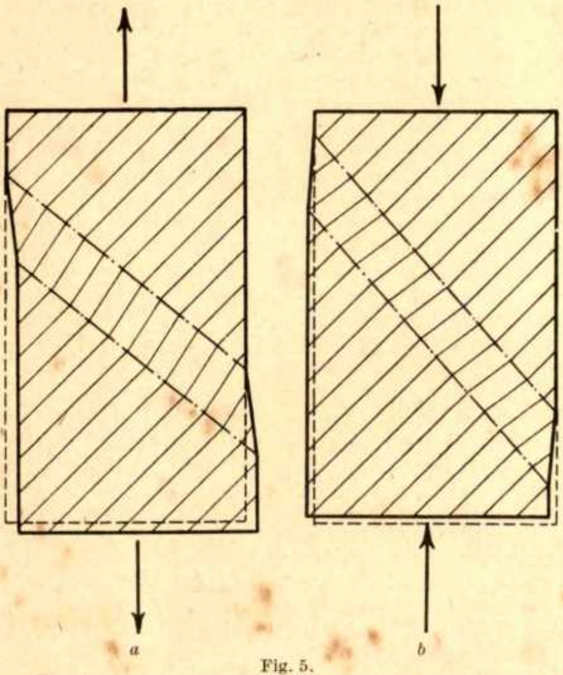

Fig. 5.
EXTENSION AND COMPRESSION OF A CRYSTAL PRODUCED BY KINK BANDS.
Thin parallel lines, glide planes.

It is known[7] that the angles between the Lueders bands in mild steel and the direction of stress are slightly less than 45° in compression, and slightly more than 45° in extension, in conformity with the behaviour of kink bands as shown in Fig. 5. Together with the sharp yield point observed in mild steel, this suggests that the deformation in mild steel may at least begin with kinking instead of glide or twinning.

Once a kink band has been formed, further deformation may take place either by glide across the band[5], or by gradual broadening of the band (displacement of the planes of kinking representing its boundaries). This latter type of deformation has actually been observed in cadmium crystals; its mechanism is identical with that theoretically postulated by Sir Lawrence Bragg some time ago[8]. In contrast with the familiar mechanism of deformation by glide packets sliding upon each other, the Bragg mechanism consists in a displacement of the boundaries between slightly differently oriented regions, such as represented by the original lattice on one hand, and the kink on the other.

[1] Mügge, O., *Neues Jahrb. f. Miner.* **1**, 71 (1898).

[2] Mark, H., Polanyi, M., and Schmid, E., *Z. Phys.*, **12**, 58 (1922).

[3] Ewald, P. P., in "The Physics of Solids and Fluids" (Blackie and Son, 1936), 121.

[4] Brilliantow, N. A., and Obreimow, I. W., *Sow. Phys.*, **6**, 587 (1934); **12**, 7 (1937).

[5] See, for example, Elam, C. F., *Proc. Roy. Soc.*, A, **153**, 273 (1936).

[6] See, for example, Orowan, E., *Proc. Phys. Soc.*, **52**, 8 (1940).

[7] Nádai, A., "Plasticity" (McGraw-Hill, 1931), 90.

[8] Bragg, W. L., *Proc. Phys. Soc.*, **52**, 105 (1940).

INDIAN FISHES AND MOSQUITO CONTROL

MUCH has already been written on the control of mosquitoes in India by introducing larvicidal fishes, and the researches of Hora and Nair resulted in successfully freeing the valve chambers of the Pulta Pumping Station of mosquito larvæ by introducing the killifish, *Aplocheilus panchax*. It was, however, still a vexed question as to whether this fish feeds preferably on mosquito larvæ in natural conditions. An interesting paper by T. J. Job[1], based on detailed experiments, shows that this fish is definitely of great practical utility in anti-mosquito campaigns. The efficiency of *Aplocheilus panchax* in

A TYPE OF PLASTIC DEFORMATION NEW IN METALS

By E. OROWAN
Cavendish Laboratory, Cambridge

SINGLE-CRYSTAL wires of zinc or cadmium, extremely soft in general, are as hard as polycrystalline wires if the glide plane (0001) is nearly parallel to the wire axis, so that the usual glide mechanism cannot work in extension or bending. In an attempt to operate the glide mechanism in cadmium crystals of such orientation, the crystals were axially compressed. As the load increased, they suddenly collapsed by forming peculiar kinks with sharp ridges and regular curvatures; the two main types of kinks are shown in Fig. 1. The regular curvatures, the non-crystallographic orientation of the planes determined by the ridges, and certain other features show that the phenomenon cannot represent ordinary glide or twinning.

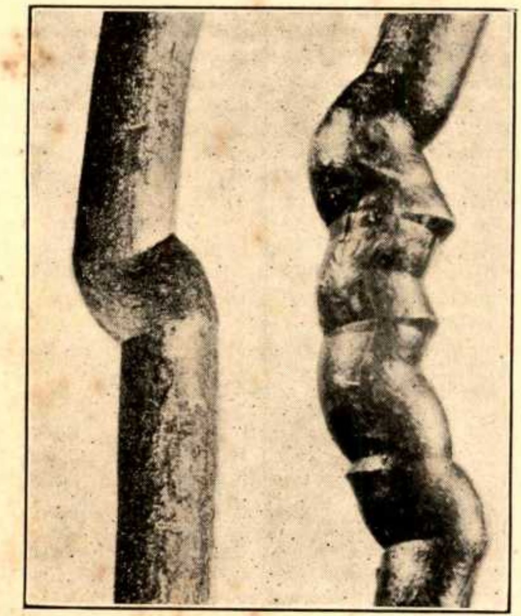
a *b*

Fig. 1.
PHOTOGRAPHS OF KINKS IN ORIGINALLY CYLINDRICAL CADMIUM SINGLE-CRYSTAL WIRES OF 1 MM. DIAMETER.

A survey of the literature showed that kinks of perfectly similar shape were observed by Mügge[1] in crystals of disthene (cyanite) compressed parallel to their glide plane. Disthene being transparent, Mügge was able to determine the lattice orientation in the kinks by means of the polarizing microscope. According to his results, the structure of the kink in Fig. 1 *a*, for example, would be that shown in Fig. 2; this has been confirmed in the present case of cadmium crystals so far as is possible with X-ray methods. Beside regions with continuously bent glide lamellæ ("flexural glide"[2,3]), the deformed crystals contain planes *k*, *k'*, in which the glide lamellæ are so sharply bent that they appear broken; hence the sharp ridges and trenches shown for both specimens in Fig. 1. This characteristic part of the phenomenon is shown schematically in Fig. 3. Under the shear stress indicated by the horizontal arrows, a part of the crystal (that above the plane *k*) splits up into submicroscopic glide lamellæ of equal thickness which swing from the initial position shown by dotted lines to that drawn in full lines. The 'plane of kinking' *k* need not be a crystallographic plane; its orientation depends on the stress conditions. For geometrical reasons, the glide planes in the 'kink' (that is, the part above *k*) are mirror images of the glide planes in the undeformed part, with the plane *k* as a mirror. In contrast with twinning, however, the *lattice* in the kink is not a mirror image of the undeformed lattice: a lattice direction shown by the double-headed arrow in the undeformed part, for example, changes to the similarly marked direction in the kink.

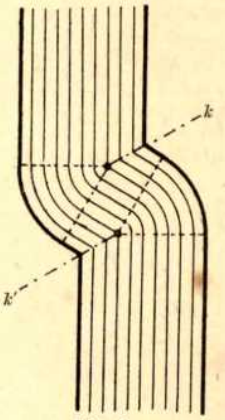

Fig. 2.
STRUCTURE OF THE KINK IN FIG. 1 *a*.
Thin parallel lines, glide planes. Broken lines, boundaries of the wedge-shaped regions of flexural glide. Dash-dotted lines *k* and *k'*: planes of kinking.

There is a characteristic difference between ordinary flexural glide and kinking. In flexural glide, the lattice constants at the compressed (concave) sides of the glide lamellæ differ from those at the extended (convex) sides; hence, the lattices of neighbouring lamellæ cannot fit upon each other, and dislocations between the lamellæ will be more or less evenly distributed over the region of flexural glide. In kinking, on the other hand, the glide lamellæ remain practically plane within a certain distance from the plane of kinking. As they swing over into their new position, they glide over each other like a row of books tilting to one side, and finally settle in a position in which the lattices of neighbouring lamellæ must be expected to fit upon each other correctly, while the dislocations are concentrated in the plane of kinking. In other words, the amount of glide between neighbouring lamellæ must be an integral multiple of the lattice period in the direction of glide. Fig. 4 shows that the amount of glide between neighbour-

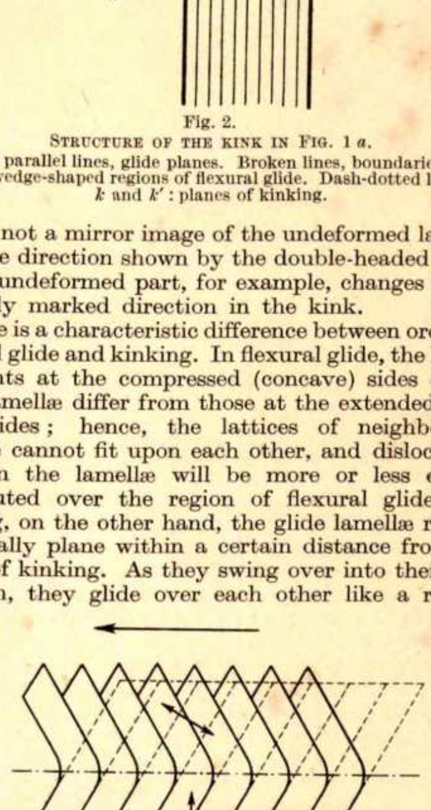

Fig. 3.
MECHANISM OF KINKING.

mosquito control has been studied by estimating: (*a*) the mosquito ratio in its diet, (*b*) the extent of check exercised by the fish in natural pieces of water, and (*c*) the effect, in the field, of introducing and of withdrawing the fish.

Food analyses of collections of fish from diverse natural habitats of rather low larval density, from observation chambers and pits of fairly high larval density, and from experimental aquaria with equal supplies of different food items, have revealed a decided preference for mosquito larvæ on the part of this fish. The author mentions the following attractive features of mosquito larvæ: convenient size, suitable pose of rest at the surface, enough mobility, absence of obnoxious exoskeleton, palatable nature and easy availability. All these must be factors which find favour with the fish.

Surveys of various types of natural water showed that whenever *Aplocheilus panchax* and mosquito larvæ occur in mutual association, and so long as the fish population is of an appreciable strength and the mechanical barriers, if any, are penetrable by the fish, the larvæ seldom thrive beyond the early instars. So far as *Aplocheilus panchax* is concerned, its efficiency for mosquito control, as proved from previous records and the present investigations, is fully established, and, being the most widely distributed and easily acclimatized of Indian killifishes, the practical possibilities of using it extensively in anti-mosquito campaigns is obvious.

The efficiency of the glassfishes (Ambassis) has also been estimated[2], and though they are less efficient than the killifish in control of malaria mosquitoes, their larvicidal activity is found to be of some significance. It is, however, in the control of the guinea-worm that the importance of Ambassis is shown, through their cyclopsidal habits. The intermediate host of the guinea-worm is known to be the copepod Cyclops or some closely related genus, and the glassfishes feed voraciously on these.

A third paper by the same author[3] deals with the bionomics of the spring eel, *Mastacembelus pancalus* (Hamilton), and shows that the number of mosquito larvæ in the gut contents is insignificant and that, "though to a small extent the fish may help to reduce the number of larvæ in marshy pools, it is not of any cognizable value in control of mosquitoes. Again . . . the proportion of *Cyclops* met with in the food of the species is too small to have any significance in the control of the Guinea-worm".

---

[1] Efficiency of the Killifish *Aplocheilus panchax* (Hamilton) in the Control of Mosquitoes. By T. J. Job, *Proc. Nat. Inst. Sci. India*, **7**, No. 3 (1941).

[2] "Food and Feeding Habits of the Glassfishes (*Ambassis* Cuv. and Val) and their Bearing on the Biological Control of the Guinea-worm and Malaria", by T. J. Job, *Indian J. Med. Research*, **29**, No. 4 (1941).

[3] "Life History and Bionomics of the Spiny Eel, *Mastacembelus pancalus* (Hamilton), with Notes on the Systematics of the Mastacelidae", by T. J. Job, *Rec. Ind. Mus.*, **43**, Part II (1941).

PROPERTIES OF RUBBER AT LOW TEMPERATURES

AN interesting account of the effect of low temperatures upon the properties of rubbers is given by M. L. Selker in an article entitled "Brittle Temperature of Rubber" (*Bell Lab. Rec.*, 20, No. 7; March, 1942). When crude rubber is held at about 14° F. (−10° C.) for some days, crystallization occurs and the rubber becomes stiff and opaque but remains elastic to some extent, permitting slight bending and stretching without breaking. Well-vulcanized rubber does not crystallize, but loses its ability to retract when stretched. Crude or elastic rubber, however, loses elasticity completely if cooled to 70–80° F. below zero. If bent suddenly at right angles a glass-like breakage occurs. This transition to brittleness occurs at a sharply defined temperature which differs for various natural and synthetic rubbers.

To study these brittle temperatures, the Bell Telephone Laboratories recently constructed a simple apparatus consisting of a quadrant (arranged to carry as many as six rubber specimens) mounted on a shaft turned by a simple crank, and supported in a narrow insulated tank into which acetone and 'dry ice', or other cooling solution, may be placed. The specimen to be tested is fastened to the quadrant and turned down into the solution sufficiently long for it to assume the bath temperature. A quick rotation of the crank then brings the specimen sharply up against a rigid metal bar projecting from the edge of the tank towards the rim of the quadrant. If the brittle temperature has not been reached, the specimen will bend, but otherwise it will break off cleanly.

It has been found that the rubber becomes so tough at these low temperatures that considerable force is required to break it. Tests carried out on natural and synthetic rubbers showed that the brittle point of soft vulcanized rubber, about − 75° F. (− 59° C.), is essentially the same for all the vulcanizing periods common in industry. Certain of the synthetic mixtures show the same behaviour. With rubber compounds vulcanized with an accelerator and a large amount of sulphur, or sulphur alone, the brittle temperature was found to vary nearly linearly with the amount of chemically combined sulphur. All the usual rubber compounds have brittle temperatures above that of crude rubber. Any addition of asphalt or resin and of many oils tends to raise the brittle temperature a few degrees. Zinc oxide and carbon black, however, can be added in large quantities with small effect. The use of appreciable amounts of coarse fillers such as calcium carbonate, on the other hand, produces compounds with high brittle points after vulcanization. The various types of reclaimed rubber can be distinguished on the basis of their brittle temperatures, that from tyre tubes having the lowest.

Only two of the synthetic rubbers are comparable to natural rubber in elasticity at low temperatures. Synthetic rubbers also differ from natural rubber in having higher brittle temperatures than their compounds.

There seems to be little relationship between brittle temperature and the size of the molecule of the substance. In general, the large molecules have lower brittle temperatures than the small, but the change seems to be sudden rather than gradual. There appears to be a definite molecular size that must be attained before the brittle temperature characteristic of the material is reached. For rubber, this size corresponds to a molecular weight between 6,000 and 30,000, while for polyisobutylene it is between 1,500 and 10,000. The difference between the brittle temperatures for large and small molecules may be very great, as exemplified by polyethylene, which has a brittle temperature of + 5° F. (− 15° C.) for small molecules, and − 91° F. (− 68·5° C.) for the large.

FORTHCOMING EVENTS

Monday, June 8

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Major Offermann: "National Parks of the Belgian Congo".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

WOMAN LECTURER IN GEOGRAPHY at the Brighton Municipal Training College—The Education Officer, 54 Old Steine, Brighton (June 10).

GRADUATE TEACHER OF MATHEMATICS AND ENGLISH in the Junior Technical School of the Castleford, Whitwood Mining and Technical College—The Director, Education Offices, Smawthorne Lane, Castleford, Yorks. (June 12).

FIRST TECHNICAL ASSISTANT (male) in the Economics Department—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (June 12).

LECTURER IN PHARMACEUTICAL SUBJECTS—The Principal, Leicester College of Technology and Commerce, The Newarke, Leicester (June 13).

LECTURER IN HORTICULTURE—The Registrar, The University, Leeds 2 (June 15).

HEADMASTER OF DERBY SCHOOL—The Acting Clerk to the Governors, Education Office, Becket Street, Derby (June 16).

GRADUATE TEACHER OF MATHEMATICS AND SCIENCE at the Grimsby Technical College—The Director of Education, Education Committee, Grimsby (June 17).

WORKS ENGINEER OF THE SALVAGE DEPARTMENT—The General Manager, Civic Centre, Birmingham 1 (endorsed 'Works Engineer') (June 20).

CHAIR OF NAVAL ARCHITECTURE, tenable at King's College, Newcastle-upon-Tyne—The Acting Registrar, University Office, 46 North Bailey, Durham (June 22).

PATHOLOGIST AND DIRECTOR OF THE CLINICAL RESEARCH LABORATORY—The Secretary and Treasurer, Victoria Infirmary of Glasgow, 40 St. Vincent Place, Glasgow, C.1 (June 27).

LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (June 30).

TWO ASSISTANT ENGINEERS with knowledge of River and Land Drainage Works—The Engineer, River Nene Catchment Board, Priestgate, Peterborough.

CIVIL ENGINEER in the service of the Government Railways, West Africa—The Secretary, Overseas Man-power Committee (Ref. 282/b), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Tin Research Institute. Publication No. 109: Report for 1941; Summarising Recent Researches and Developments in the Uses of Tin in Industry. Pp. 12. (Greenford: Tin Research Institute.) [145

Family Allowances. Memorandum by the Chancellor of the Exchequer. (Cmd. 6354.) Pp. 11. (London: H.M. Stationery Office.) 2*d*. net. [145

Iron and Steel Institute. Special Report No. 28: Second Report on Refractory Materials. Being a Report by the Joint Refractories Research Committee of the Iron and Steel Industrial Research Council and the British Refractories Research Association. Pp. v+168+3 plates. (London: Iron and Steel Institute.) 16*s*. [155

Hull Museum Publications. No. 192: Index to Hull Museum Publications, Nos. 145–191. Compiled by T. Sheppard. Pp. 56. No. 212: Record of Additions. Edited by Thomas Sheppard. Pp. 58. No. 213: Bronze-Age Implements (in the Mortimer Museum, Hull). By T. Sheppard. Pp. 40+13 plates. (Hull: Hull Museum.) [215

Current Trend of Population in Great Britain. (Cmd. 6358.) Pp. 12. (London: H.M. Stationery Office.) 2*d*. net. [265

Proceedings of the Royal Society of Edinburgh. Section B (Biology), Vol. 61, Part 3, No. 19: pH Phenomena in relation to Stomatal Opening, 2–5. By Prof. J. Small, Miss M. I. Clarke and Mrs. J. Crosbie-Baird. Pp. 233–266. (Edinburgh and London: Oliver and Boyd.) 2*s*. 9*d*. [295

University of London. Report of the Acting Principal on the Work of the University during the Year 1941–1942. Pp. 8. (London: University of London.) [295

Other Countries

U.S. Department of the Interior: Geological Survey. Bulletin 883-C: Spirit Leveling in Texas, Part 3: West-Central Texas, 1896–1938. Pp. ii+151–239+1 plate. 15 cents. Bulletin 906-F: Phosphate Investigation in Florida, 1934 and 1935. By P. V. Roundy. (Contributions to Economic Geology, 1938–39.) Pp. iv+267–345+plates 55–63. 30 cents. Bulletin 915-D: Geophysical Abstracts 99, October–December 1939. Compiled by W. Ayvazoglou. Pp. ii+133–195. 10 cents. Bulletin 916-H: Transit Traverse in Missouri, Part 8: West-Central Missouri, 1906–37. Pp. xiii+1025–1156+1 plate. 20 cents. Bulletin 917-B: Geology of the Upper Telling River District, Alaska. By Fred H. Moffit. (Mineral Resources of Alaska, 1938.) Pp. iv+115–157+plates 2–7. 50 cents. Bulletin 918: The Goodnews Platinum Deposits, Alaska. By J. B. Mertie, Jr. Pp. iv+97+9 plates. 50 cents. Bulletin 919: Spirit Leveling in Michigan, 1896–1938. Pp. iii+523+3 plates. 65 cents. Bulletin 920: Pre-Cambrian Geology and Mineral Resources of the Delaware Water Gap and Easton Quadrangles, New Jersey and Pennsylvania. By W. S. Bayley. Pp. v+98+5 plates. 40 cents. Bulletin 921-A: Manganese Carbonate in the Batesville District, Arkansas. By Hugh D. Miser; with a Chapter on Minerals of the Ores, by D. F. Hewett and H. D. Miser. (Contributions to Economic Geology, 1940.) Pp. v+97+10 plates. 60 cents. Bulletin 922-R: Quicksilver Deposits in San Luis Obispo County and Southwestern Monterey County, California. By E. B. Eckel, R. G. Yates and A. E. Granger. (Strategic Minerals Investigations, 1940.) Pp. v+515–580+plates 78–87. 75 cents. Bulletin 923: Geology and Mineral Resources of the Randolph Quadrangle, Utah–Wyoming. By G. B. Richardson. Pp. v+54+8 plates. 55 cents. Bulletin 925-B: Geophysical Abstracts 101, April–June 1940. Compiled by W. Ayvazoglou. Pp. ii+51–92. 10 cents. Bulletin 925-C: Geophysical Abstracts 102, July-September 1940. Compiled by W. Ayvazoglou. Pp. ii+93–126. 10 cents. Bulletin 926-A: Mineral Industry of Alaska in 1939. By Philip S. Smith. (Mineral Resources of Alaska, 1939.) Pp. iii+106+1 plate. 20 cents. Bulletin 931-A: Tungsten Resources of the Blue Wing District, Lemhi County, Idaho. By Eugene Callaghan and Dwight M. Lemmon. (Strategic Minerals Investigations, 1941.) Pp. iii+21+5 plates. 30 cents. Bulletin 931-B: Some Quicksilver Prospects in Adjacent Parts of Nevada, California and Oregon. By Clyde P. Ross. (Strategic Minerals Investigations, 1941.) Pp. iii+23–37+plates 6–8. 25 cents. (Washington, D.C.: Government Printing Office.) [155

U.S. Department of the Interior: Geological Survey. Professional Paper 193-E: Additions to the Wilcox Flora from Kentucky and Texas. By Edward W. Berry. (Shorter Contributions to General Geology, 1938–40.) Pp. ii+83–99. 15 cents. Professional Paper 195: Geology of the Kettleman Hills Oil Field, California: Stratigraphy, Palæontology and Structure. By W. P. Woodring, Ralph Stewart and R. W. Richards. Pp. v+170+57 plates. 1.50 dollars. (Washington, D.C.: Government Printing Office.) [155

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 849-A: Geology and Ground-Water Resources of the Lufkin Area, Texas. By W. N. White, A. N. Sayre and J. F. Heuser. (Contributions to the Hydrology of the United States, 1940.) Pp. iv+58+2 plates. 30 cents. Water-Supply Paper 849-B: Effect upon Ground-Water Levels of Proposed Surface-Water Storage in Flathead Lake, Montana. By R. C. Cady. (Contributions to the Hydrology of the United States, 1940.) Pp. iii+59–81+plates 3–10. 35 cents. Water-Supply Paper 851: Surface Water Supply of the United States, 1938, Part 1: North Atlantic Slope Basins. Pp. iv+496+1 plate. 60 cents. Water-Supply Paper 879: Surface Water Supply of the United States, 1939, Part 9: Colorado River Basin. Pp. vii+309+1 plate. 35 cents. Water-Supply Paper 882: Surface Water Supply of the United States, 1939, Part 12: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. vii+246+1 plate. 30 cents. Water-Supply Paper 883: Surface Water Supply of the United States, 1939, Part 13: Snake River Basin. Pp. viii+315+1 plate. 30 cents. (Washington, D.C.: Government Printing Office.) [155

Smithsonian Miscellaneous Collections. Vol. 101, No. 11: Amphipod Crustaceans collected on the Presidential Cruise of 1938. By Clarence R. Shoemaker. (Publication 3677.) Pp. ii+52. (Washington, D.C.: Smithsonian Institution.) [195

Proceedings of the United States National Museum. Vol. 92, No. 3135: Some Cestodes from Florida Sharks. By Asa C. Chandler. Pp. 25–31. (Washington, D.C.: Government Printing Office.) [195

Forest Research in India and Burma, 1940–41. Part 1: The Forest Research Institute. Pp. iii+161. (Delhi: Manager of Publications.) 1.12 rupees; 2*s*. 6*d*. [265

Annual Report of the Imperial Council of Agricultural Research, 1940–41. Pp. iv+190+10 plates. (Delhi: Manager of Publications.) 2.12 rupees; 4*s*. 6*d*. [265

Indian Forest Records (New Series). Utilisation, Vol. 2, No. 5: Experiment on the Air Seasoning of *Pinus longifolia* (Chir) Sleepers in the East Almorah Division, U.P. By M. A. Rehman. Pp. vi+109–150+4 plates. (Delhi: Manager of Publications.) 1.2 rupees; 1*s*. 9*d*. [265

Bureau of Education, India. Appendices to Education in India in 1937–38. Pp. iii+48. (Delhi: Manager of Publications.) 14 annas; 1*s*. 3*d*. [265

Imperial Council of Agricultural Research. Proceedings of the Fourth Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India, held at Izatnagar (Bareilly) from the 18th to 20th November 1940; with Appendices. Pp. 250. (Delhi; Manager of Publications.) 5.10 rupees; 8*s*. 9*d*. [265

University of Pennsylvania. Theoretical Magnetic Susceptibilities of Metallic Lithium and Sodium. A Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. By John Bard Sampson. Pp. 8. (Philadelphia: University of Pennsylvania.) [265

University of Pennsylvania. The Electrical Conductivity of Titanium Dioxide. By Marshall Delph Earle. A Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. Pp. 10. (Philadelphia: University of Pennsylvania.) [265

University of Pennsylvania. The Theory of Gaseous Isotope Separation in a Force Field with Application to the Ultracentrifuge. By George Harold Wilson. A Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. Pp. 26. (Philadelphia: University of Pennsylvania.) [265

State of California Department of Natural Resources: Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 58: The Commercial Fish Catch of California for the Year 1940. By the Staff of the Bureau of Marine Fisheries. Pp. 47. (Terminal Island, Calif.: California State Fisheries Laboratory.) [265

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KNOWLEDGE AND ACTION

IT would be easy from the recent debates in the House of Commons on the war situation or those in the House of Lords on the organization for joint planning to derive a false impression of national dissension at a time of crisis. The temper of the House of Commons debate ran high at times, and very clearly there are intrigues and some resentment against the Prime Minister and his advisers, accentuated to some extent by the Government's apparent yielding to party pressure and sectional interests over the Beveridge report on coal rationing. In the House of Commons, indeed, the debate was at a lower level than in the House of Lords, concentrating rather on the demand for a real Chief of Staffs, as distinct from the Minister of Defence, than on the more fundamental need for a Great General Staff and for combined commands wherever the Services work together.

Such an interpretation, however, would mistake the whole tone of the criticism which the Government, like any Government in the third year of war when a militant and aggressive spirit is widespread in the nation, must always face from a free people. It springs from the call for proof of action: that the industrial resources are fully mobilized for the final stages of the struggle, and that the Government will finally assert its authority against private interests. It is primarily a call for leadership of the highest order, and springs from the growing recognition that the development of our maximum effort is a matter of science and knowledge and not merely tradition, and that it involves scientific management and wise administration as well as a commanding character and original intellect.

From many quarters has come evidence of the outstanding importance of administration and management at the present time. This is strikingly illustrated in the account of the Western Electric Company researches which is included in a recently published report "Fatigue of Workers: its Relation to Industrial Production" by the Committee on Work in Industry of the U.S. National Research Council. Social conditions as a rule are far more potent in their effect on efficiency than physical conditions. The most urgent task is that of solving these problems of command, production and industrial organization with foresight as well as with pertinence and expedition. We need the really great administrator of Bagehot who "thinks not only of the day but of the morrow; who is eager to extirpate every abuse and be on the watch for every improvement; is on a level with the highest political thought of his time and persuades his age to be ruled according to it in policy and in laws".

These words of Bagehot's describe almost exactly the mood of the nation and the essence of its criticism—lack of foresight, of resolution in dealing with abuses, and of earnestness in seeking for improvement. Given, however, administration in this large sense, concerned with the far-seeing regulation of future conduct as well as with the limited management of the present, it can only be fully effective with the full support and co-operation of management as of people. The soundest policy may be frustrated by inefficient or incompetent management, and no administration can remain unchallenged which fails to use its powers to remove whatever obstacles lack of vision, incompetence or private interest may place in its path.

If, therefore, it is a profound mistake to judge that the nation is not united and that the Government does not still command the support of an overwhelming majority of the people, it would be a fatal error not to recognize that continued support depends, not on what has been done in the past, but on what is done now to strike against the enemy abroad or against vested or sectional interests at home. The debates, like the coal situation itself, hold a warning of dangers which may rapidly develop in the absence of resolute leadership.

While the Beveridge scheme still holds the field on the consumption side as a scientific method of providing prompt, fair and effective rationing, on the production side the industry has to demonstrate its inherent capacity to solve its problems. For a quarter of a century it has set its face against all plans for reorganization advanced by independent investigators to secure efficiency. To this Sir Richard Redmayne's recent book "Men, Mines and Memories" is a significant witness. Rationing of fuel, in fact, without reorganization of the coal industry, would be a disaster alike from the point of view of our war effort and of the peace to follow, when an efficiently organized coal industry will be no less imperative.

There can be no question as to the growing scale upon which both scientific methods and knowledge are being made available. Prof. A. V. Hill's inspiring Gustave Canet Memorial Lecture to the Junior Institution of Engineers on May 22 on "Scientific Research and Development in the Empire" (see p. 653 of this issue) and the recent appointment of Dr. C. G. Darwin as scientific adviser to the Army Council, however, will not dispel the uneasiness which recent events have aroused in the minds of scientific workers and others as to the will of the Government to use scientific knowledge to re-shape the nation's economy when the needs of victory so demand. The Government has, it is true, accepted the main recommendations of the Citrine Committee, but the exceptions made may well prove crucial. The main recommendation of the report is that the principle of devolution must be applied to the office of the Minister of Production: "Just as the Minister of Production is charged with the duty of concerting and supervising the activities of the supply Ministries at the centre, so there should be in each region a representative of the Ministry whose duty it should be to concert and supervise the activities of the Regional Controllers of the Supply Departments."

The core of the Citrine Committee's plan is thus to have regional directors of production with this task of supervision to ensure the maximum degree of co-ordination. The Government, however, has already rejected this recommendation, and there are to be regional controllers, each of whom will indeed be chairman in his region of the regional board and of its executive committee, but he will at most be *primus inter pares*. It will still be impossible for regional facilities to be fully pooled and utilized. It is, of course, a distinct gain that most, if not all the most important, regional organizations for specific matters will now be centralized, physically as well as administratively, under the regional boards. The proposals making the regional boards cognizant of all the contracts placed and all the work in progress in their areas so that they can keep constant watch over the flow of orders and deliveries and over the use of capacity are to be welcomed, but it should be noted that vital exceptions have been made by the Government to the recommendation that the independent organizations established by the Supply Ministries for capacity-finding should be merged in the regional organization.

The regional organization of the Admiralty is to be excluded even when it is concerned with non-shipyard work. The regional organization of the Controller General of Machine Tools is to be excluded; and owing to the limitations imposed on Mr. Lyttelton himself in the matter of labour, the regional controller of production will have no more than joint powers with the regional controller of the Ministry of Labour over the allocation of labour. Given the right type of man of wide industrial experience and local knowledge visualized by the Committee, the new system may indeed prove better able to control effectively the local allocation of resources, to marry capacity and requirements, so that no capacity is unused and no requirements are unfulfilled. It puts a strain on the human factor, however, that the Citrine Committee's own recommendations might avoid, and it is difficult to escape the conclusion that once again the Government has missed a great opportunity presented by an admirable report of an expert committee.

There is, indeed, much to ponder in this penetrating analysis of organization. The first principles are sometimes laid down with disconcerting frankness. The emphatic and unanimous opinion that an efficient regional organization is an essential element in the effective prosecution of the War is accompanied by the equally emphatic opinion that an essential pre-requisite for the effective functioning of any regional machinery of co-ordination is a properly articulated system of devolution of executive authority. There is a tribute to the organization of the Ministry of Labour and National Service, and the Committee considers that the same method of organization could and should be equally applied to the other factors of production. Indeed, the report suggests that had there been developed correspondingly effective machinery for the collection of information about manufacturing capacity, for placing contracts and sub-contracts and for dealing with progressive problems comparable with that under central control for dealing with the man-power problem with which we entered the War, not only would the task of the employment exchanges in redistributing skilled labour for the purpose of building up new production units with unskilled labour have been made easier, but also, with adequate supplies of raw materials, the tempo of production would have been accelerated without a corresponding increase in the demand for machine tools or floor space.

There are trenchant observations on the failure to give the existing regional boards the opportunity of playing a continuous and effective part in securing the fullest possible use of the manufacturing resources of Great Britain, on the neglect to consult the Central Joint Advisory Committee, on the delays which result from failure adequately to plan the distribution of work and on the wastefulness of the establishment of capacity clearing centres of their own by the Supply Ministries. The Committee's ideas on the functions of the Boards, on their constitution, on the district organization and on those of the National Production Advisory Council which it proposes, are as clear and as sound as their views on decentralization, and their observations and recommendations are further supported by evidence in the Seventh and Eighth Reports of the Select Committee on National Expenditure, which have appeared since the Citrine Committee commenced its investigations.

The failure to implement the proposals of an impartial or expert inquiry is indeed one of the fundamental reasons for public anxiety at the present time, in spite of growing appreciation of the magnitude and efficiency of much of the national effort, as reflected, for example, in the recent report on conditions in a royal ordnance factory made by a deputation from a local trades and labour council which had received complaints as to idle hours, idle machines and lack of sympathy between management and workers at the factory. The deputation of six which visited the factory with the permission of the Ministry of Supply concluded its report with the words: "If this factory is a fair sample of those being run by the Ministry of Supply, their greatest critic will have to go very far before he can find a concern run by a private enterprise to equal them in the provisions made for the comfort and convenience of the employees." Management and administration have indeed great achievements to their credit, but the national effort will only reach its maximum when the standards of the best obtain everywhere and the latest advances in technique and knowledge are applied with wisdom, with firmness and with understanding both of men and materials. How much yet remains to be done in this field by the establishment of closer relations between management and worker is indicated by the Western Electric researches already mentioned.

It is at this same point that the debate in the House of Lords on May 5 betrayed misgivings. On the question of the organization for joint planning and the issue of a Great General Staff or a Chief of Staff as advocated by Sir Edward Grigg, little that was new was advanced, but there were significant observations as to the place of the scientific and technical experts. Lord Denman, for example, urged that fuller use should be made of the services of scientific men and technical experts, and suggested a chain of technical authority from the Army Council down to the military units in the field. He was concerned about the utilization to the best advantage of our great scientific and technical assets. Lord Swinton again emphasized the essential part which the integration of science and strategy and operations in the Air Ministry has played in making the victory of our pilots possible. In his view the Sub-Committee of the Committee of Imperial Defence, on which sat the Chiefs of Staff of the three Services or their deputies, the directors of development and production in Production Ministries or the Service production branch and the scientific advisers formed an integral part of the Combined General Staff, and gave the scientific side both the status and the opportunity of playing their part to the full; that common meeting-ground no longer exists, and Lord Swinton held that no organization exists by which scientific men can play their part in framing strategy to-day.

Mr. Lyttelton, it is true, has already indicated his plans for meeting this need in regard to the production side, but the marriage of scientific with operational staffs and in framing strategy as well as tactics is more than ever necessary to-day. Lord Milne pointed to the difficulties which arose when the whole of the supply technical services were taken out of the hands of the Army and transferred to the Ministry of Supply. That the Army should have been incidentally deprived in this way of technical advisers in such a technical war is, of course, a serious matter, and Lord Milne's plea for some return of staff and for a technical staff to consider research, preferably a joint technical staff linking the experience and requirements of the War Office with the activity and possibilities of the Ministry of Supply, is most reasonable. The need will no doubt be met, to some extent, from the new corps of Royal Electrical and Mechanical Engineers.

Lord Hankey himself, like Lord Trenchard, lent powerful support to the plea for a joint technical staff as part of the Combined General Staff and for bringing scientific workers into the central control of the War—a matter which need not wait on the appointment of the Chief of the Joint General Staff for which Lord Hankey pressed. Lord Chatfield's reply on this point was unconvincing, like that of Lord Simon. Organization of scientific research is already fairly effectively co-ordinated in ways which Lord Hankey as well as Lord Chatfield has outlined on previous occasions. That, however, is not the point at issue. The vital question is that of securing that the immediate study of strategy and tactics by the General Staff is conducted with an awareness of the possibilities which technical and scientific advance have put in our hands. That cannot be done by Service chiefs in isolation from scientific workers, or without some real appreciation of the scientific and technical factors involved.

The fundamental problem is the perennial one of relating effectively knowledge and action, whether against the enemy abroad or against any private interest at home which stands in the way of the nation's purpose. It calls for the application of those basic principles of the Haldane Report on the Machinery of Government which have too often been overlooked in debate as in policy: the integration of the field of work and the separation of planning from administration. In those principles lies the clue to the solution of the fuel problem as of that of production or the planning of combined operations. The nation has no reason to doubt that we possess the resources of materials, of technical or scientific skill, of men and women and of staying power and character required for victory, or even that leadership of the requisite calibre cannot be found for whatever onerous co-ordinating posts may be necessary. There is, however, real concern at the moment, less at the quality of our leadership than as to its determination to use both its authority and resources. The simplest demonstration that the Government accepts the principle that nothing shall be left undone that serves the national purpose would dispel such concern, but such a demonstration is imperative. No longer can the nation be left in doubt as to whether suaveness of manner is merely a cloak for tenderness to sectional interests when the national purpose demands swift, resolute and courageous action.

R. W. WOOD OF BALTIMORE

Doctor Wood, Modern Wizard of the Laboratory
The Story of an American Small Boy who became the most Daring and Original Experimental Physicist of our Day—but never Grew Up. By William Seabrook. Pp. xiv+335+13 plates. (New York: Harcourt, Brace and Co., Inc., 1941.) 3.75 dollars.

FEW American scientific men can be better known in Great Britain than the subject of this biography. The author has been in close touch with him, and has had every opportunity of gaining authentic information. The book is a popular one, and, as is perhaps natural and inevitable, has less to say about Wood's scientific achievements in developing resonance radiation and resonance spectra than about his personal adventures in various scientific and semi-scientific fields such as the aviation of early days, thawing frozen pipes, war work and scientific detection of crime. We are left with the impression that, successful as he has been as an experimenter, he could have done equally well as a conjuror or a variety entertainer.

The choice among many interesting topics for comment is almost embarrassing. Wood had for years been interested in filters transparent to ultra-violet light but opaque to the visual. The nearest approach to this generally available before his time was dense cobalt glass, which was used in Stokes's original investigations on fluorescence, but which is very far from the ideal. Wood introduced the use of nitroso-dimethyl aniline; but this, though it separates ultra-violet from blue much better than does cobalt glass, lets through a good deal of yellow. During the War of 1914–18 Wood gave his attention to the question again, and, arguing perhaps from the chemical analogy of cobalt and nickel, he tried a glass containing nickel oxide. This isolates the ultra-violet very satisfactorily, letting through no visual light, though of course it has the same limitation as ordinary glasses, that it stops wave-lengths shorter than λ 3000. This glass has many applications. One of them mentioned in the book is for the detection of secret writing by fluorescence. There is a very instructive incident told on p. 205. Wood was in Great Britain as a scientific-military officer and was being shown the secrets of the base censor's office. "What goes on in that cupboard?" he asked. It was too secret to be shown. "Ultra-violet light, I presume," said Wood. Eventually he was shown it. It was the old method used by Stokes in 1855, of cobalt glass to cut out the yellow and green from the source, and a yellow glass over the observer's eyes to cut out the blue. Wood happened to have a sample of his nickel glass in his pocket, and showed them how superior it was. Where could they get such glass? Answer: "Already in use at Portsmouth Dockyard; why have you not got them already?"

This kind of thing may well reduce scientific men who are called in to deal with war problems to despair. It was quite typical, and one would like to know whether in the interval of peace during 1918–39 anyone gave his mind to the question of how it was to be avoided in future. The answer would almost certainly be in the negative.

We are told how Wood took part in the investigations on the "spiritualistic" phenomena of Eusapia Palladino thirty years ago. He invented various ingenious methods of testing her, but does not seem to have had the opportunity to apply his methods satisfactorily. One of her phenomena was the bulging out of a curtain without obvious cause. Wood adheres definitely to the view that it was blown out by a current of air artificially produced. Readers of Sir J. J. Thomson's "Recollections" will find that he inclined to a quite different explanation. Eusapia was definitely caught in fraudulent manipulation by Dr. Hodgson and Mrs. Sidgwick, but it must be remembered that a paid medium has to 'deliver the goods' in order to earn a living; and if there really are genuine efforts, and if they will not come at pleasure, the temptation to imitate them fraudulently must be very strong. It is possible therefore to over-emphasize the unfavourable conclusions to be drawn from detected fraud. Some serious students of the subject still believe that genuine phenomena were, on occasion, produced by Eusapia, but, practically, their opinion can scarcely carry much weight.

This kind of investigation is difficult enough when we have only to attempt to gauge whether or not the paid professional mediums are deceiving the investigators. But if the investigators cannot be trusted not to deceive one another it indeed becomes almost hopeless. We are told of how Wood made use of some private knowledge which he happened to possess to deceive Dr. J. H. Hyslop and Sir Oliver Lodge. Hyslop had every reasonable ground for supposing that Wood could not have possessed this knowledge normally, but he happened to be wrong in so thinking, and Wood, pretending to be in a kind of dream state, intentionally led him to believe that it had been acquired in some supernormal way by telepathy. If this had been immediately afterwards confessed, and used to point a moral of the necessity for caution, it might pass. As it was not confessed, we do not think that it was justifiable to treat a brother scientist and a sincere searcher after truth in this way. Practical joking of this kind is a dangerous game, and may inflict grievous injury on the victim. For example, Paul Kammerer is said to have been driven to suicide because thoughtless students had deceived him by faked evidence for the inheritance of acquired characters. In any case, the incident reads oddly in a chapter entitled

"Debunker of Frauds". The boot seems rather to be on the other leg. The most favourable view is that Wood was on this occasion, as the title-page indicates, acting like a boy who has never grown up.

It is understood that Wood's energies have, of recent years, been largely devoted to the problem of ruling diffraction gratings which will throw most of the light into a single spectrum. In stellar spectroscopy there is no more important experimental problem than this one, and probably none better suited to our hero's peculiar talents. The need is always for more light, and the enormous sums spent on large telescopes are eloquent of this. But for many purposes it would be as good or better to double the amount of light thrown into a given spectrum as to double the area of the telescope objective; and, once we know how to do it, the cost would be incomparably less. So far, little is known in Great Britain of the details of Wood's methods, except that he makes his rulings on aluminized glass. We see in the bibliography of this book that a paper was due to appear in the *Astrophysical Journal* for December, 1941, but in fact no number appeared at all for that month. There are, if we understand rightly, hints of very large transmission gratings also.

We recommend the book as amusing reading, and are glad that a vivid personality has been recorded as a contribution to the history of science in our era.

RAYLEIGH.

EDUCATION AND NATURE

Truth and Fallacy in Educational Theory

By Charles D. Hardie. Pp. x+151. (Cambridge: At the University Press, 1942.) 6*s*. net.

MR. C. D. HARDIE's book is the kind of book which causes one to look backward, to look around, and then to look forward. He writes as a philosopher, and therefore as one engaged in an obstinate effort to think clearly. Though he does not express it in so many words, his real aim seems to be to show up the confusions in educational theory that have arisen from ambiguities in the use of the term 'Nature'.

As far back as the 1860's Herbert Spencer wrote his forceful and influential essays on education "according to Nature". He was consciously indebted to Pestalozzi, who in turn drew his inspiration from Rousseau. Speaking generally, we may say that writers of this type held that intellectual education should be based upon sense-impression, since that is the method of Nature, and that moral education should be based upon the discipline of consequences, that again being the method of Nature. Spencer waxes almost lyrical in praise of the blind forces of Nature, as against the meddlesome activities of parents, nurses and teachers. But during the closing decade of the century, there came to Great Britain from Germany, chiefly by way of America, the opposing influence of Herbart, who had no use for a theory of education which belittled instruction and guidance. For a child running down a steep declivity the intervention of the mother was just as much a part of Nature's plan as the pitiless operation of the law of gravity. Herbart's whole system exalted the province of parent and teacher, so much so indeed as to incur with justice the charge of over-direction. Hence the welcome accorded to the movement associated with the name of John Dewey. According to him, the way appointed by Nature, if we only understood her, was that of letting the child take the lead, not the teacher. This principle, embodied in the so-called project method, has in some hands been carried so far as to sacrifice what is best in the traditional 'grind', and to provoke a protest from Dewey himself. That is where our 'progressive' teachers now stand.

In his first three chapters Mr. Hardie passes in critical review each of the movements above described. Much of his criticism has, of course, been anticipated by previous writers, but the modern ring in his remarks is refreshing, as when he shows that the laws of arithmetic have nothing to do with little operations with beads and beans, that it is far from being 'unscientific' to accept results on authority, and that Herbart's conception of many-sided interest—for which Mr. Maxwell Garnett would substitute a single wide interest—has much to say for itself if understood in a deeper sense than that of merely "making things interesting".

Proceeding from these discussions of ambiguities and fallacies, the author in his fourth chapter sets down what he conceives to be the basis on which an educational theory should be built. Recalling many definitions of education, showing some agreement and some important differences, he asks whether there is one that is right and all the rest wrong. In the course of the chapter there are valuable discussions of the elusive conception of instinct, of the still more elusive conception of intelligence, of the transfer of training, of heredity and its importance (or otherwise) for education, and lastly of the conception of value. This final topic leads the author back to his question whether there is one definition of education that is right and all the rest wrong. He ends with a plea for tolerance, for no one of them is right and no one wrong.

The reviewer feels moved to add that the book makes unnecessarily difficult reading, partly because of the inherent obscurities of the subject, and partly through causes that seem to him remediable.

T. RAYMONT.

FAULTING AND DYKE FORMATION

The Dynamics of Faulting and Dyke Formation: with Applications to Britain

By Dr. E. M. Anderson. Pp. xii+191. (Edinburgh and London: Oliver and Boyd, 1942.) 15*s*. net.

THIS book can be warmly recommended to geologists, who will read it with great interest and profit. The theory of principal stresses had long been applied by engineers to explain fractures in materials, but it was the author who first applied it in explanation of the main types of rock fractures or faults well known to geologists. From field experience these had been classified into three main types called strike faults, dip faults and oblique faults which conformed to neither of these directions. With increasing knowledge it was found that the majority of those in the first class were overthrusts while those of the second class were mainly normal faults. It was only later that the oblique faults were better understood; many of these have now been proved to be associated with some horizontal movement parallel to the earth's surface, and they have been called tear faults, transcurrent faults (the name favoured by the author), and a variety of other names.

In 1905 Anderson, by applying the theory of principal stresses, in conjunction with Navier's principle of internal resistance to shearing proportional to the normal stress, succeeded in elucidating the general stress conditions that might give rise to these three types of fractures and showed that faults in general conformed to the deductions from the theory. Since then he has applied the same principles in explanation of intrusions of cone-sheets or inclined sheets characteristic of the Tertiary Igneous province of the Inner Hebrides. In the book under notice the latter are excluded, but dykes and sills are brought within the same principles and some interesting deductions are made regarding their possible mutual relations, which are discussed in some detail.

It is considered that fault fractures are in general produced by shearing stresses, whereas in the emplacement of dykes the fractures are the result of tension or at least of pressures across the trend of the dyke substantially less than the pressure of the magma at the point of rupture.

The principal stress theory as applied to faulting is now fairly well known among geologists, and some years ago the Geological Society of London organized a joint meeting with the Royal Astronomical Society (Geophysical Discussion) at which its relation to the formation of faults and other fractures was discussed. Its re-statement and the special applications dealt with in this book will, however, be genuinely welcomed.

Several areas in Great Britain are described, and the general stress conditions which are revealed by their fault systems are deduced. Attention is directed to those regions where the faulting is either of Caledonian or Armorian age but mainly the latter, since faulting of that age has been more closely studied on account of its effects in coal mining. The investigation is therefore only a beginning, but it is likely that its presentation in a form which can be easily understood will result in a closer study by geologists of the stress conditions that prevailed in other areas and of other periods, and thus help to build up the tectonic history of the British Isles and other regions throughout the ages.

In the presentation of the theory in 1905 the effects of superposing shear stresses on the principal stresses were suggested. Its omission in this book leads the author into difficulties in interpreting certain faults in South Wales and elsewhere. D. W. Phillips has shown the importance of taking these into account in explaining induced cleavage produced near a working coal face.

The author perpetuates the mathematical fiction of tension in the earth's crust, which is difficult to appreciate in view of the fact that fault fractures must, in general, have their origin at a depth where high pressures must prevail in every direction. Tension is apparently regarded in the same way as a relief of pressure. It is difficult to conceive of a stress deep in the earth's crust changing in a short interval of time from a pressure to a tension in the same direction but mathematically a relief of pressure is perhaps regarded as a tension superposed on the pre-existing pressure

In general, if one horizontal stress at some depth is increased, an element of the crust is shortened in the direction in which it is applied and lengthened in all directions at right angles, the amount of extension being given by Poisson's ratio. The extension is, however, opposed by the resistance of adjoining elements, and in this sense an increase of pressure in one horizontal direction brings into play a pressure in directions at right angles which is in a certain ratio to the increase of applied pressure.

The author considers increase and relief of pressure by reference to an imaginary 'standard state' where the horizontal pressures are approximately equal to the vertical load of the column of rock. This conception tends unduly to divorce the phase of faulting from preceding phases (such as folding) during which the conditions have long been different from the standard state.

It would take too long to follow the author in his detailed analysis of various areas of faulting. A study of the post-Carboniferous faulting leads to the conclusion that the directions of stress during the formation of these faults remained remarkably similar over a large part of Great Britain. In particular examples, however, sufficient allowance is not made for local variations in the stresses which controlled the directions of certain faults. One example occurs in the South Wales coalfields and South Pembrokeshire. In the latter area strike faults and tear faults occur in association with one another and with folding. In the main coalfield there is also some folding, but the dominant structures are the 'north-north-west' faults. The author is inclined to group these with the north-north-west tear faults of South Pembrokeshire with which, however, they have little in common. The fold axes of the coalfield change gradually in direction from east-north-east in the east to about east-west in the west, and taking these as an indication of the direction of the greatest horizontal stress, the faults lie very near that direction and thus conform to the stress conditions of normal faults, which in fact they are.

In the same field there are complex belts called 'disturbances', of which one near the Tawe Valley is but an example of many parallel structures; these are generally believed to be younger than the north-north-west faults. They are, however, probably a reflexion in the Palæozoic rocks of deep-seated fractures in the pre-Cambrian floor which are liable to move with any great increase of stress in the area. Two faults are deflected in crossing the Tawe disturbance, as shown in Fig. 21. If, however, a counter-clockwise shear in the direction of this disturbance is superimposed on the principal stresses of the adjoining region, the deflection of the two faults is explained.

Another great fault belonging to the same general system is the Church Stretton fault, which is now under investigation for a great part of its length. This fault belt is a symptom of deep-seated conditions which may have caused local modifications in the general stress distribution that prevailed outside the belt at various times.

There is an interesting discussion of the conditions necessary for the production of dykes and sills and for the passage occasionally observed of one into the other.

The reader is cautioned against accepting the statement of enormous horizontal displacement along the line of the Great Glen fault until more critical evidence is produced than has hitherto been made known.

O. T. JONES.

SCIENTIFIC RESEARCH AND DEVELOPMENT IN THE EMPIRE*

By PROF. A. V. HILL, O.B.E., F.R.S., M.P.

Canet

IT might seem a bitter irony of fate that a lecture should be given in memory of a great French engineer, in the field of artillery, who lived so long in England and had so many intimate connexions here, at a time when a Government of traitors in France is actively aiding the common enemy against her ally. Were Jean Baptiste Gustave Adolphe Canet alive to-day, we know very well where his heart would be. "It would be impossible", it has been said of Canet, "to record his innumerable acts of consideration and regard for the Junior Institution of Engineers", of which he was an honorary member, a vice-president, and president in the year he died. It would be impossible for an Englishman who has been intimate with Frenchmen of his kind not to believe that France will rise again, purged by her misfortunes, to better things. The world cannot do without a nation which can produce men of his genius, whether for engineering, philanthropy or friendship.

Empire Science

France, however, does not come very far into the story of scientific research and development in the Empire, which I have to tell to-day, though it is true that the Dominion of Canada was originally French, that a significant part of its culture is still French, that scientific men and engineers of French origin take an important part in Canada's life, and that Henri Laugier, head until the fall of France of the French equivalent of the Department of Scientific and Industrial Research, is busily engaged there now in work devoted to our common cause. Predominant as may be, so far, the Anglo-Saxon part in Empire science, significant contributions have been and are being made by almost every national group within it. It is a common enterprise of all the peoples of the Empire, biased locally in direction by local requirements and facilities, but carried on everywhere in the same spirit, by the same methods and with the same standards of accuracy and objectivity.

The chief object of this lecture will be to try to indicate how closer and more effective scientific co-operation within the Empire can be obtained.

Imperial Collaboration in War Research

In the early days of the War my colleague and co-secretary of the Royal Society, Prof. A. C. Egerton, and I, convinced of the enormous prospective advantage to our common war effort of close consultation with organized science in the Dominions, discussed the matter with Sir William Bragg, then president of the Royal Society, who, from his twenty-two years at Adelaide, was very well acquainted with science in Australia, and had close connexions with scientific men in the other countries of the Empire.

Fortunately, Dr. R. W. Boyle, of the National Research Council of Canada, was in London at the time—having escaped from Poland, where he had been on holiday when war broke out—and discussions with him then helped to bring our plans to later fruition. That winter also, Dr. Madsen came to England from Australia to obtain information about certain important scientific and technical developments here which must be of vital importance now, with Australia in the front line of battle. Then early in 1940 the opportunity occurred of going for a period, on behalf of the Air Ministry, to the British Embassy in Washington; an opportunity which I seized, seeing in it the means of making arrangements for scientific collaboration, on the one part between Britain and the United States (not yet in the War, but warmly sympathetic), on the other part between Canada and the "old country", as they affectionately say. There was no difficulty of any kind in Canada —only anxiety to see the thing put through—and plans were accordingly made. In Washington one was confidently assured that the President would instantly respond to an approach from the British Government—which, in fact, he did when the approach was ultimately made.

In August 1940, the Canadian plan was started off by Prof. R. H. Fowler going to Ottawa to act as scientific liaison officer with the National Research Council, and to develop an informal connexion with scientific men in the United States. A little earlier the National Defense Research Committee had been formed in Washington, with Dr. V. Bush as chairman. Finally, in the autumn of 1940, Sir Henry Tizard took a mission to Canada and the United States. No words can overstress the importance of what was achieved by that mission and by Fowler's strenuous efforts.

In the meantime another plan we had had at the Royal Society, since the summer of 1938, also reached shape and fruition, and the Scientific Advisory Committee of the War Cabinet was formed—most fortunately under the chairmanship of Lord Hankey.

It is difficult now to remember good-humouredly the further unnecessary difficulties which arose, but finally an office of the National Defense Research Committee was established at the American Embassy in London and a British Central Scientific Office in Washington; while representatives of Canadian and Australian science were appointed to the offices of their High Commissioners in London. To these a continual flow of scientific men and engineers, engaged in various projects, has come; while in the persons of Mr. Nevill Wright, of the New Zealand office, and of Colonel B. F. J. Schonland, of South Africa, representatives of those Dominions also have been available in our counsels. Attempts have been made, but unsuccessfully so far, to establish similar arrangements with Indian science.

Speed in Travel and Transmission

The contributions which have been made already by this organized collaboration have been very important, and now that it is running sweetly greater results still will accrue. It is quite impossible to achieve more than a small fraction of what is needed merely by correspondence and by the circulation of reports, drawings and specifications: personal contact and personal initiative are needed also, for which it is necessary to provide, on the one hand permanent or semi-permanent scientific liaison officers in the various centres—as has now been done—on the other, means of rapid transport for short visits by experts either way. The rapid transfer also of correspondence, documents and drawings, and of small samples, is essential—for the former, given air transport, the microfilm method, which is rapidly coming into its own, is of very special advantage.

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* Substance of the ninth quadrennial Gustave Canet Memorial Lecture of the Junior Institution of Engineers on May 22.

Great difficulty is still experienced from slowness of travel and transmission of scientific people and information. At present official communication with the United States may take anything from two to six weeks. It is too slow. With Australia and New Zealand and South Africa now it is essential that safe and rapid transfer of information should be possible.

The Future

The presence in London of so many representatives of science in the Empire, in close and frequent contact with their colleagues at home by visits and correspondence, offered the opportunity of instituting a discussion of joint problems, quite apart from those immediately connected with the War. The persons concerned would naturally be very busy with urgent work, but the question of future scientific collaboration within the Empire, and, arising from that, with the United States, was so important that a general consideration of it at occasional informal meetings would be possible and fruitful. The two main objects of discussion might be, first, emergency problems of the immediate post-war era, and, secondly, the possibility of making the most of our common scientific resources and heritage for improving both scientific knowledge itself and the life of the peoples of the Empire.

With this in view, the officers of the Royal Society called a conference in October 1941 of the representatives of the countries of the Empire, together with the officers of the Society, the secretaries of the Agricultural Research Council, the Medical Research Council, and the Department of Scientific and Industrial Research, and others. The president, Sir Henry Dale, in opening the conference, mentioned the ideal of continued collaboration in time of peace, saying that the material structure of society depends on science, and that if reconstruction was to be tackled on a properly international scale science must once more become an international activity. A first step towards this could probably best be taken on the initiative of scientific men of the British Empire and the United States together; for example, the International Scientific Unions would have to be started again, if possible on better lines. Sir John Madsen, from Australia, felt sure that great interest would be taken by the other Governments of the Empire in the view of the United Kingdom Government in this matter; he suggested that an extension of facilities for meeting and working with their colleagues elsewhere would greatly improve collaboration, and that the first activity of a committee to be set up, following the conference, might be to explore the facilities at present available and the means of extending them. General A. McNaughton, as president of the National Research Council of Canada, offered every possible help and support for the objects of the conference, and considered that the interchange referred to should occur, not only between universities, but also between industrial and Government laboratories in the different countries, including if possible the United States: he did not believe that if scientific people were convinced that this interchange was necessary, financial difficulties need stand in the way. Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, hoped that permanent liaison officers would be maintained in scientific and technical matters in peace-time as well as war. Sir Henry Tizard foresaw financial stringency as regards interchange for educational purposes, as distinguished from specific research, but urged that exchange would be particularly valuable between the universities of the Empire during undergraduate years, especially in applied science.

Lord Hankey welcomed the calling of the conference and said he felt sure that during the exploratory work proposed to be undertaken the inquiry would branch out and important new points of interest emerge. He referred to the advantage of having a scientific advisory committee with a Cabinet Minister as chairman, to bring science into direct contact with the centre of government. If in each country of the Empire the scientific organization was thus arranged, there would grow up gradually an official appreciation of science, since from time to time, as ministries changed, one Cabinet Minister after another would be taking a special interest in science. Colonel Schonland (South Africa) urged the importance of considering the scientific needs and possibilities of Africa as a unit; and he added in a later letter to me: "It is not a question of money at all, but of brains and sound organization."

A number of others took part in the discussion, and it was recognized that later on it would be most desirable if possible to secure close collaboration with official and unofficial science in the United States; all were agreed that popular lecture tours did not at all fulfil the purpose in mind; special reference was made to co-operative work in agriculture; and the conference then appointed a committee to look into the various proposals made.

I have described the discussion at this conference in some detail because of the great importance of several of the points raised, because it may be the beginning of an important movement towards closer scientific collaboration, and because many in other parts of the world may be glad to know of what is going on. It is not easy in times like these to get much more work out of busy people, but the committee appointed (which, in addition to representatives of the Royal Society and of the Dominions and India, has included Sir David Chadwick, secretary of the Imperial Agricultural Bureaux) has met already seven times; and owing to the initiative of its secretary, Dr. Alexander King, scientific liaison officer in the Ministry of Supply, much information has been collected and discussed on science in the Empire and on facilities for interchange in advanced study and research. The representatives of a variety of interests have been interviewed, including the research associations, the Universities Bureau of the British Empire, the 1851 Exhibition Studentships, the Leverhulme Fellowships and the British Council; and a variety of suggestions have been made and followed up. All this will serve as the basis for further exploration and planning, and it is intended next to proceed to the discussion of concrete proposals to improve the machinery of collaboration.

The Colonies

In all this discussion there has been no specific reference so far to the Colonies, only to the Dominions and India. The scientific problems and the possibilities of scientific development in the Colonies, Protectorates and Mandated Territories are, however, of great importance, and considerable attention has, in fact, been devoted to them for some time. In 1927, for example, the Colonial Office formed a Colonial

Medical Research Committee, a mixed body of administrators and scientific members. Little, however, was done, but in 1936 the Colonial Office asked the Medical Research Council to supervise research in tropical disease, a project which this time seemed likely to be highly successful, but was interrupted by the War. Under the Colonial Development and Welfare Act, 1940, two funds have now been created, one of £5,000,000 a year for ten years for Colonial development and welfare generally, one of £500,000 a year without time limit for Colonial research. A director of a proposed Colonial Products Research Institute, it is hoped, will shortly be appointed; the products in question are those of biological origin. A Colonial Research Advisory Committee is to be set up under the chairmanship of Lord Hailey, which will not only advise on the expenditure of £500,000 per annum, but also will "advise upon and co-ordinate the whole range of research in Colonial studies".

The Imperial Agricultural Bureaux, founded in 1929, are concerned with agricultural matters in the Colonies as well as in all the other countries of the Empire. The Imperial Institute, founded in 1887, has five main departments, dealing with the commercial, industrial and educational interests of the Empire, particularly in relation to raw materials, to research upon them and to the development of their use and supply; minerals, plant and animal products, exhibition galleries, intelligence, statistics, library and laboratories are among its many activities. The Institute has many difficulties to contend with, not least the fact that with its enormous field of interest its annual budget is only £48,000, less than 1*d.* per square mile of the Empire whose natural resources it surveys, less than 3*d.* per square mile if calculated for the area of the Colonies alone!

An Africa Research Council

One of the suggestions made to the British Commonwealth Science Committee, to which I have referred, is that for the purposes of scientific research and development Africa might be treated as a separate unit, the work being a joint concern of the scientific organizations of the United Kingdom on the one hand and of the Union of South Africa on the other. Among the subjects to be treated, for which Africa as a whole has special needs and opportunities, might be tropical diseases, social anthropology and race relations, native languages, ethnology, geology, geophysics and meteorology.

The formation of an Africa Research Council, a joint interest both of governments and private benefactors and individuals, as so many of the best of our British institutions are, might lead to developments of the kind required for specifically African problems. There is no other region in the world in which the same variety of researches is needed, all to some degree for geographical and political reasons inter-related; if the different elements of this variety could be treated each as part of the whole scientific problem of Africa, and made to fit into the other elements, the results might be much more satisfactory and more far-reaching in importance than if all were studied separately according to subject and locality. A good example of the need for such an Africa Research Council is shown by the failure, before the War, to get a badly needed geodetic survey of Africa started, because there was no body in existence to father it.

It is clear that a scheme of this kind must wait for better times: it would involve the setting up of a central office and council, the collection and allocation of funds, the distribution of work and interests between it and other agencies, and the foundation of new or the development of existing research institutes, in Great Britain or in various parts of Africa. In view, however, of the obvious advantages it might have, it may be well to throw it now into the arena of discussion, so that on one hand it may be thought about, on the other so that no action may be taken in the meantime which might make it in the future more difficult to realize.

Existing Scientific Agencies in the Dominions and India

The scientific organization of the Dominions and of India is so highly developed, in universities and research institutions, in industry and under Government auspices, that no account of it, valuable as one would be, could be given in a lecture. The National Research Council of Canada is the equivalent, roughly, of the Department of Scientific and Industrial Research and the Medical Research Council in Great Britain, and of the research departments in the Service and Supply Ministries. It has great resources and a magnificent record, particularly in the present War. In Australia, the Council for Scientific and Industrial Research is the approximate equivalent of our Department of Scientific and Industrial Research and under the able leadership of Sir David Rivett it has made very important contributions both in peace-time and for the defence of Australia in the last three years. In South Africa the National Research Council, with advisory functions, and the National Research Board, with administrative functions, together with the South African Institute for Medical Research, take a prominent part in scientific developments in the Union. In New Zealand the Scientific and Industrial Research Department plays an analogous role. In India, the Board of Scientific and Industrial Research, under the able directorship of Sir Shanti Swarupa Bhatnagar, has taken a very active part in mobilizing the scientific and technical resources of India since its foundation in 1940; the Survey of India, the Zoological Survey, the Botanical Survey and the Geological Survey, the Indian Science Congress and the Indian Research Fund Association (medical) all have obvious and important tasks to fulfil.

This is merely a selection for purposes of illustration; Government agencies, universities, and private benefactions are responsible for innumerable others: in education and research; in application to defence, to industry and transport and to medicine and public health; in agriculture; for improving knowledge on one hand and the life of the people on the other. In each of these countries science and the scientific outlook, research and its application, make up a great and living organism. No doubt in each of them much remains to be done, as it does in Great Britain; but what is chiefly needed, and what will help beyond any other single factor in forwarding the promotion of science itself and its application to the public welfare is closer contact, more intimate knowledge, quicker and more frequent communication, a better intelligence and information service, easier exchange, between the several living parts of the whole living organism of science spread across the Empire, and—I should like to add—the United States.

Freedom of Research

I have talked a good deal about co-operation and collaboration, but not—you may have noticed—about co-ordination. Science is a free growth, and, as Sir David Chadwick recently wrote in a note to the British Commonwealth Science Committee: "much of the most valuable research must be free . . . To many who rightly prize that characteristic of research, the word 'co-ordination' denotes 'sinning against the Holy Ghost'. . . . One must bear in mind that the countries in the British Commonwealth have developed on different lines. These lines may meet in the end, but their starting points have been poles asunder."

This warning must be remembered. Co-ordination is necessary, within limits, to help to guide research into profitable channels and lest waste, overlap or its converse may occur ; but in dealing with a group of proud and independent nations, however friendly and co-operative, we and they must all beware of attempting to introduce a degree of direction, authority or control which many will certainly resent. The Imperial Agricultural Bureaux represent an ideal of equal partnership in the co-operative dissemination of information on research. There is no reason why similar collaboration should not be built up about similar bureaux in other scientific subjects, or, for example, around the libraries and information services of the industrial research associations, the Imperial Institute, or other similar bodies in Britain or the Dominions. London need not necessarily be the focus for all. Co-ordination will then come naturally with increase of knowledge, contact and information. Co-operative research is a living, growing organism ; it must be carefully tended, not just pushed into a mechanical framework planned from outside.

We hear a good deal about planning, and planning of scientific research we must certainly have. An Africa Research Council, for example, if it were to be set up, would require a deal of planning. Freedom, on the other hand, is the material and moral basis of the British Commonwealth, and requires explicit recognition in all we do or say. In some way planning and freedom must be combined. There is in this, as in most human affairs, an optimum mixture, the right proportions of which we must seek and find. This optimum must be aimed at, here in Britain, in the action and reaction of free science and free initiative with science and initiative provided by the State. It must be aimed at independently, perhaps with a different final mixture appropriate to their conditions, in each of the countries of the Empire ; and it must be sought in the freely accepted co-ordination of the scientific activities of the different parts of the whole Commonwealth.

My own faith is that improvement in knowledge, contact, communication, familiarity between the scientific people of the Empire—and of the United States—will allow that co-ordination quietly to be achieved, the planning to be successfully undertaken, without any violation of the freedom on which we all set so great store, about which we are all so sensitive. It comes back again, therefore, to quickness, ease and facility of travel, transport and communication—things which engineers, in one way or another, must provide. For I believe that scientific people—and engineers—are on the whole rather more reasonable and practical—if not very much—than other folk, and that when we get to know each other by working together on a common job, we are generally ready to appreciate and understand the other fellow's difficulties and virtues and his point of view. The common job exists obviously enough in the scientific development of the Empire, for the improvement, as I repeat, of knowledge and of the life of its people : the important thing therefore is to improve the methods and technique of getting down to it together.

FAMILY ALLOWANCES

By D. CARADOG JONES

University of Liverpool

THE subject of family allowances—assistance given in cash rather than in kind, to meet the cost of maintaining children during the period of their dependency—bids fair to become a live political issue. It is now nearly twenty years since Miss Eleanor Rathbone's much-debated book, "The Disinherited Family", was published, wherein she made a powerful and piquant plea for the introduction into Great Britain of some system of communal payment for the important task of rearing children. Other countries had seized the opportunity presented by the War of 1914–18 to slip in the thin edge of the wedge and the breach thus made was afterwards widened, but Great Britain allowed that chance to pass.

It may seem odd that a time of war should be considered appropriate even for the discussion of such a subject. There are several reasons to account for it. When things are upside down, people are more ready to listen to revolutionary proposals. By grafting on to the normal bargaining process for settling wages a scheme of children's allowances, the needs of the family are taken into account as well as the skill and merit of the worker. To accomplish this would clearly be difficult unless prices are rising, and they invariably do rise during wars ; and if wages are to keep step with the cost of living, there is much to be said for a sliding scale graduated according to the number of mouths to be fed. The payment of war-time separation allowances encourages, too, a widespread habit of expecting the weekly income to conform to the size of family. Moreover, under war conditions, the unmarried young man, if left to earn good money by making munitions instead of being obliged to serve in the Forces, would be unlikely to wish to attract critical attention by complaining if his pay does not rise in the same proportion as that of the man with a family.

Trades union leaders in Great Britain have in the past been either antagonistic or only lukewarm in their attitude towards family allowances, largely from a fear that they might be used to depress their standard of living. In countries such as France and Belgium there was the same fear, but it did not persist in any marked degree after the introduction of a compulsory State system covering a large proportion of the employed population. Under the type of scheme favoured by these countries, the allowances were financed by equalization funds, to which contributions were made by all the employers engaged in a specified industry or resident in a defined region. The sum put into the pool by each employer was proportional to the number of his workers or to his total wages bill. This simple device overcame the difficulty that some firms might otherwise have been tempted to employ only single men or men with very small families.

Advantages Claimed

Although the British Government may be presumed still to maintain an open mind as to the wisdom of introducing family allowances, a step forward has now been taken by the issue of an official memorandum on the subject (Parliamentary Paper, Cmd. 6354. London: H.M. Stationery Office. 2*d.* net) following a deputation of members of Parliament which the Chancellor of the Exchequer received in June of last year.

Advocates urge the disadvantage under present conditions, when everything possible should be done to avoid inflation, of meeting the rise in the cost of living by a flat increase in wages which puts extra money into the pockets of many people who do not need it. Any additional sum that can be spared towards wages, if distributed in the form of family allowances, would go, they say, some way to prevent malnutrition in households containing several small children. There is also the familiar claim that family allowances may arrest the decline in effective fertility. On this point the evidence derived from the experience of France and Belgium is not very conclusive, according to D. V. Glass, who has made a careful examination of the material. In his "Population Policies and Movements", published early in 1940, he says (p. 202): "it is evident that they have not been influential enough to cause a rise in fertility, or even to stabilise fertility at its already low level of five or ten years ago. On the other hand, it is probably true that the family allowance system in France has helped to reduce infant mortality, and it is likely that this has also been the case in Belgium."

When families are not far from the border-line of poverty, there is no doubt that the advent of babies aggravates their economic condition, which inevitably reacts on the health and nutrition of all the members of the household. Evidence of the appreciably higher incidence of poverty among children than in the general population was obtained in the course of three social surveys, namely London, Merseyside and York. It is evident, therefore, that to subsidize the maintenance of children should be one profitable way of attacking the problem of poverty. But, while agreeing to this, it is still possible to hold the view that it might be wiser to give the subsidy in kind—better provision of infant welfare services, school dinners, improved housing, or some other form of social assistance—rather than in the form of a cash allowance to the parents, who might be tempted not to spend it on the children.

Contributory and Non-Contributory

The main arguments for and against family allowances are summarized in the Government White Paper without discussion. The cost is then estimated on various alternative assumptions. Thus, an allowance might be paid in respect of every child in the family; it might be paid only in respect of the second and subsequent children; or it might be paid only in respect of the third and subsequent children. Again, the scheme might apply to all parents, or it might be limited to parents below an agreed level of income, or to parents who are already subject to compulsory national insurance. The advantages and disadvantages of these various alternatives are briefly examined in the memorandum. Other equally important questions arise for consideration. Should the scheme be paid for by the State, the employers, the parents of the beneficiaries, or by some combination of these three parties on the principle adopted for national insurance purposes? Finally, if the scheme is to be contributory, should it be also compulsory?

Let us start with a contributory scheme. It is estimated that, in order to provide a flat-rate allowance of 5*s.* a week for each child of parents in insurable employment, the child to be less than fifteen years of age unless still receiving full-time education, the weekly contribution which would be required of every employed person (other than juveniles presumably) would amount to 2*s.* 8*d.* a week. As a matter of practical administration, the scheme would in this case no doubt be fitted on to the existing contributory pensions scheme, and the contribution conditions would be the same for both; in other words, the State, the employer, and the worker would each contribute a share of the total estimated cost. It is further assumed that full contributions would be paid into the pool in respect of members of the armed forces, that equal contributions would be paid in respect of men and women, and that parents would continue these payments even when in receipt of benefit. The last-mentioned assumption means in effect that the nominal weekly allowance of 5*s.* for the parent with one child would be reduced to 2*s.* 4*d.*

No allowance has been made in this estimate for the cost of administration and, in view of the relatively small net benefit available, it would seem that a non-contributory scheme—though more costly to the public in general—might give a better return for the labour and expense incurred. We pass on therefore to consider a scheme where the whole expense would be borne by the Exchequer.

The estimated gross cost of a non-contributory scheme giving allowances at 5*s.* a week in respect of each child as before is £132 million a year. If the first eligible child in each family were excluded from benefit, the gross estimated cost would fall to £58 million a year. These calculations are made on the assumption that the allowances would be available for all classes of the population irrespective of their incomes. Additional estimates have been made, however, on two different assumptions: (*a*) that the benefits would only be available to parents with incomes of £260 a year or less; and (*b*) that the benefits would only be available to parents already compulsorily insured for contributory pensions or, if not so insured, whose incomes amount to not more than £420 a year.

Clearly, the administration of the first of these two alternative schemes would involve a means test and for that reason it might not be very popular. The second scheme would be much easier to administer, because the bulk of the families eligible for benefit are already dealt with for national insurance purposes. Confining our attention accordingly to the (*b*) scheme, it is estimated that the gross cost of providing 5s. a week for every eligible child in the family would be £124 million a year. If the first eligible child were excluded from benefit, the gross annual cost would be reduced to £55 million.

These are the gross estimates, but the actual net cost under each head would be rather less, because there would be some saving of expenditure on children's benefits provided by existing social services of one kind or another. These benefits would naturally be revised to avoid duplication with family allowances. For example, where the needs of the family are assessed for the determination of benefits, as in making grants of unemployment assistance, family allowances would have to be taken into account.

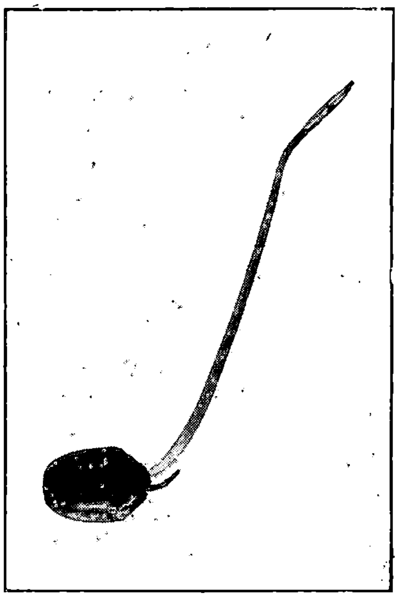
It is impossible to estimate all such savings with precision. In so far as an estimate can be made, the total sum saved is put at £7 million a year for a scheme covering all eligible children, and at £3 million for a scheme covering all eligible children except the first in each family. These same figures are used whether the benefits are to be available for all parents or confined to a particular class. It follows that for a universal scheme, covering all parents, the estimated net cost under existing conditions to provide a flat-rate allowance of 5*s.* for every child less than fifteen years old, or over that age if still receiving full-time education, would be £125 million a year; and to provide allowances for all except the first eligible child in each family the net cost would be £55 million a year. The corresponding figures for a scheme confined in the main to the classes in the population which are already subject to compulsory national insurance would be £117 million and £52 million.

It would be unfortunate if we missed this opportunity of introducing a long-overdue reform. It might be well to start modestly with a scheme covering every eligible child except the first in each family, but to make it universally applicable since, if we can accept the above figures as reasonably accurate, the difference in cost between the universal and the limited scheme is relatively so slight. This would be of help to all except the smallest families. Eugenists would like also to give additional encouragement to families with the best heredity, but to discover the 'best' in this sense and to define it for administrative purposes would be difficult.

RECENT WORK ON GERMINATION

OPENING a discussion on seed germination held at the Linnean Society on May 14, Dr. M. A. H. Tincker, of the Royal Horticultural Society's Gardens, Wisley, read a paper dealing with the physiology of germination and incorporating some hitherto unpublished data of germination studies made at Wisley. The importance of low-temperature storage with low relative humidity tested in the United States was illustrated by common vegetable seeds including onion, carrot, leek and tomato. The response of seeds or achenes to various 'stratification' periods and temperatures so fully worked out at the Boyce Thompson Institute was also brought under review. With a number of lilies the seedling roots may grow but the shoots of certain species frequently do not appear for a year or more; while a higher temperature favours root growth, the dormancy of the epicotyl may be terminated by exposure to lower temperatures for a month or two. The seeds of further species of Primula have been shown to be light sensitive. Vernalization studies made at the Imperial College, in which very small embryos may grow into large plants almost as rapidly as normal grain, have an important bearing upon the question of small and large seed. The conditions favourable to the growth of small embryos in Fraxinus were mentioned, as was the widely different behaviour of the acorns of different oak species in regard to their after-ripening requirements in contrast to their similarity in respiration during winter. The interesting artificial methods used in Java of division of young, valuable seedlings of rubber at an early stage of germination to give a greater number of plants were described.

Mr. T. Hay referred to the germination of Emmenanthe (whispering bells) in soil which has been heated. *Romneya coulteri* also germinated better in heated soil. He stated that *Grevillea robusta* seed when placed in soil edgewise gave a higher germination than when flat. He mentioned the great difficulty experienced in raising many Cypripediums and the failure of imported seed. Referring to temperature conditions he cited Nemesia as germinating better at low temperatures despite its origin, and in regard to age and maturity preferred two-year-old leek seed and stated that old seed of stocks gave a higher proportion of doubles. He concluded by recounting the interesting story of the re-introduction of *Lathyrus magellanicus* by seed.



NELUMBIUM FROM THE SLOANE COLLECTION.
Placed in water, after removal of seed-coat, at 5 p.m. on May 12, 1942. Temp. 32° C. At 2 p.m. on May 13, ½in. long. Kept at room temperature afterwards and photographed on May 17, at 10 a.m.

Mr. G. W. Robinson remarked upon the slow germination of Hellebore seed often after 3–4 years from date of sowing, and commented on the Primulas, some of which proved troublesome. High temperatures in bush fires, well known to cause germination in Acacia spp., were observed in South America by him to cause *Sisyrinchium striatum* to germinate readily. Seed some eighty years old of Cytisus, Melilotus and other species had been successfully germinated.

Dr. J. Ramsbottom exhibited seedlings of *Albizzia Julibrissin* and Nelumbium. The seeds of the Albizzia were collected during Sir George Staunton's mission to China in 1793 and then stored in the Department of Botany at the British Museum. Following the fire in the Department at South Kensington due to an air raid in September 1940, the seeds became damp and when they were examined in November, were found to have germinated. Three of the seedlings were planted, and grown on at Chelsea Physic Garden; only one, however, survived the air attacks of May 1941. The main interest is that the seeds germinated 'spontaneously' after their 147 years storage.

Three Nelumbium seedlings were shown. Two of these were grown from fruits ('seeds') found in the prehistoric peat bed in the Pulantien Basin, South Manchuria: they are "probably at least three or four hundred years old". The seeds were presented to the Museum by Prof. I. Ohga in 1926; at that time in his experiments they showed a very high percentage of germination. The seeds, after the removal of their seed coats, germinated in water at 32° C., one after twenty-one hours, the other by the following morning. The third seedling was grown from a 'seed' taken from a receptacle in the Sloane collections. Robert Brown during 1843–1855 succeeded in obtaining twelve seedlings from fourteen of these seeds. As they were then not less than 150 years old this has stood as the record for longevity of seeds of known origin: Ohga tried twelve seeds in 1926 but none germinated though one seed, on being opened, showed green cotyledons. Only one seed was tried and within twenty-one hours it produced an outgrowth half an inch in length which had increased to more than an inch before the end of the second day. The Sloane Catalogue cannot be consulted conveniently at present so no exact data are available, but eighty-seven years have elapsed since the last of Robert Brown's classical experiments. The most surprising fact about the germination is the immediate rapid and rampant growth after a dormancy of centuries.

Mr. C. P. Raffill dealt with difficulties experienced in seed importation, stating that only 10 per cent of the seed importations into Kew gave satisfactory germination. He had experienced the greatest difficulty with seeds from Malaya, South America, East Australia, and East and West Africa and Ceylon. Magnolia seed from China and the Himalayan region failed when imported dry, but when kept moist by moss some germination was obtained. The seed of Michelia and related plants proved short-lived. Many plants from New Zealand (including Araliaceæ) produced seed which apparently died on drying; seed of Nothofagus also was imported successfully in damp storage but unsuccessfully when dried. Reference was made to the small degree of success obtained with the seeds of many tropical fruits.

In a brief reply Dr. M. A. H. Tincker referred to the availability of rapid means of transport by air and of modern methods of temperature control which should be tested for seed importation.

ELECTRICITY OF CLOUD AND RAIN

By DR. J. ALAN CHALMERS
University of Durham

IN his recent presidential address to the Royal Meteorological Society, under the above title, Sir George Simpson[1] has given a full account of experimental results on the processes giving rise to electrical charges on raindrops and in clouds. Due largely to work in which Sir George has himself taken a big part, a fairly clear picture is now available of the electrical structure of a thunder-cloud, showing a positive charge above and a negative charge below, with a localized concentration of positive charge at a still lower level. There must be two processes of separation of charge: an upper one, in a region where the temperature is below freezing-point, and where the separation has been ascribed by Simpson and Scrase[2] to a process of friction between ice-particles, giving a negative charge to the larger particles and a positive charge to the air; and a lower one, where the precipitation is entirely in liquid form, and where the separation of charge is ascribed to the breaking of drops, giving positive drops and a negative charge to the air.

But, as Sir George Simpson points out, the electrical phenomena associated with continuous rain, such as that preceding a warm front, are by no means so clearly understood. Although the meteorological conditions are probably less complex than in a thunder-cloud, the electrical manifestations are much less intense; and technique, such as that of the alti-electrograph, which is available for the investigation of thunder-clouds, is not sufficiently sensitive for the purpose of investigating clouds of the nimbo-stratus type responsible for continuous rain.

The investigation of electrical phenomena due to continuous rain clouds has been mainly confined to the measurement of the charges on the rain and of the vertical potential gradient at the earth's surface. It has been generally found that the charge on the rain is predominantly positive, while the potential gradient is usually negative; the correlation between the two has been established in the case of long-continued gentle rain, in a record analysed by Chalmers and Little[3] and in records mentioned by Simpson[1].

The problem of the electricity in continuous rain and the clouds responsible for it amounts to the discussion of the production of positively charged rain and a negative potential gradient. The negative potential gradient must be due to a negative charge situated in the base of the cloud or below it.

Electrical Processes at Work

The fundamental problem in regard to the electricity of continuous rain is one which can be stated in a number of different forms, now seen to be equivalent. In its simplest form it is as set out by Simpson[1], namely, the question as to how the rain gets its positive charge. There are two known processes by which water drops could obtain a positive charge under conditions of the kind under discussion: there is the process of the breaking of drops put forward by Simpson[4], which is recognized as responsible for the positive charge in the base of the thunder-cloud; and there is the 'influence' process suggested by Wilson[5] and verified in laboratory experiments by Gott[6].

The breaking-drop process leaves a negative charge in the air, and this will give rise to the negative potential gradient directly. On the other hand, if the influence process gives a positive charge to the drops, there must first be a negative potential gradient below the cloud, due to a negative charge in the base of the cloud. If, within the cloud, there is the same process of ice-friction which operates in the thunder-cloud, this will give the requisite negative potential gradient.

The two processes which could give rise to the charges on raindrops are sharply distinguished in regard to the origin of the charges in the cloud and the consequent negative potential gradient. The breaking-drop process will, in itself, give rise to a negative charge in the cloud, and there will be no need for any positive charge to be assumed in the cloud. On the other hand, the influence process requires a 'bipolar' cloud, with negative charge below.

In the breaking-drop theory, the primary result of the process is the positive rain, the negative potential gradient being a consequence of this; whereas in the other process, the first effect must be the production of a bipolar cloud, with negative potential gradient beneath, the positive rain arising from this by the influence process.

It is, of course, possible that both processes occur in the same cloud, as is the case in a thunder-cloud; then the negative charge in the base of the cloud may be partly due to the charge in the air from the breaking of drops and partly due to the process which gives a bipolar cloud.

Vertical Electrical Currents

The problem can be regarded in a different way if we make use of the important fact that conditions within and near a cloud giving continuous rain are quite steady; therefore whatever electrical processes may occur will probably not give rise to any marked changes in the distribution of electricity and give no added accumulations of charge. Thus we have the general principle that, for any one cloud, the total vertical electric current density must be nearly the same at all levels and so the same above, within or below the cloud; if we can determine the current density at any one level we know, approximately, its value at other levels. In particular, if by any argument we can determine the sign of the current density at any one level we know the sign at other levels. The vertical electric current is composed of the current carried by the rain, the conduction current and any convection current due to space charges carried up by vertical air currents.

Currents above the Cloud. It is perhaps simplest to discuss the vertical electric current density above the cloud, where the only current must be a conduction current between the ionosphere and the top of the cloud. If the cloud is bipolar, the potential of the top of the cloud may be higher than that of the ionosphere and hence there will be a negative current downwards. On the other hand, if the cloud is negative, the downward conduction current above the cloud will be positive. It is to be expected that the ions comprising the conduction current will originate in the ionosphere rather than in the cloud, and therefore the results of Wigand[7], who used a balloon to make measurements of conductivity above a stratiform cloud, are important. Wigand found the conductivity to be mainly due to negative ions, which is in agreement with the idea of a bipolar cloud, rather than a negative cloud.

Current within the Cloud. It can be seen that the same results occur if we consider the processes of separation within the cloud. In the formation and maintenance of a bipolar cloud, the process of separation gives a negative current downwards, as also occurs above the cloud; while in the breaking-drop process there is a positive current downwards. In the case where both processes occur in the same cloud, the upper process may produce charged drops which fall to the level where the lower process occurs, but there can be little effect of the lower process at the higher level, so that the resultant vertical electric current will be negative downwards.

Current below the Cloud. Below the cloud the vertical electric current consists mainly of the rain current carrying positive charge downwards and the conduction current carrying positive charge upwards. The sign of the resultant current therefore depends on the relative magnitudes of these two currents. Whereas the rain current can easily be measured, the conduction current is largely due to point-discharge, and though this can be measured for a single point, it can only be converted into a current density by assuming the separation of points equivalent to the one used; this has been discussed by Chalmers and Little[3] and by Chalmers[8]. If there is a bipolar cloud, the conduction current must be greater than the rain current, to give a resultant negative current downwards, while if there is a negative cloud the rain current is the greater.

Wigand's balloon measurements of conductivity below the cloud show a predominance of positive conductivity, as would be expected from the positive ions produced by point discharge.

Results for Snow

Since the breaking-drop process, and probably also Wilson's influence process, are effective for water in the liquid state only and not in the solid state, we should expect the results for snow to differ from those for rain. Simpson[1] has pointed out that the potential gradients during snowfall show no significant difference from those during rainfall; this indicates that the process responsible for the potential gradient does not depend on the presence of liquid water, and so cannot be the breaking-drop process, but must, presumably, be a process within the cloud below the freezing-point, for example, the ice-friction process. There seems a general consensus of experimental evidence that continuously falling snow carries a negative charge, and this is what we should expect if there is a bipolar cloud and no influence process by which the negative charge on particles from its base is lost and positive acquired. The results for snow are in agreement with the idea of a bipolar cloud, giving rise to a negative potential gradient, which, when there are raindrops, makes these positive by Wilson's influence process.

Eiffel Tower Observations

Chauveau[9] has given an account of observations undertaken at the Eiffel Tower which are of importance in connexion with the present discussion. Chauveau found that, frequently during continuous rain, the potential gradient at the top of the Eiffel Tower remains positive, though less than its fine-weather value, while that at the foot of the Tower is negative. As can be seen by drawing lines of force, the only interpretation of this, as the Tower is a conductor, is that the atmosphere between the levels of the top and foot of the Tower carries a negative charge. Since this would quickly be dissipated by conduction currents, there must be some process at work which provides a negative charge at this level but leaves no positive charge within the atmosphere; the breaking-drop process operating near the earth's surface would account for these results very simply, giving also the positive charge found on the rain.

It seems difficult to reconcile these results with those for snow, since in the absence of the breaking-drop process we should expect matters to be the same at the foot of the Tower as at the top, that is, with a reduced positive potential gradient rather than a negative. It is also difficult to reconcile these results with the predominantly positive conductivity below clouds found by Wigand.

Conclusion

Apart from the Eiffel Tower observations, the general trend of the results for continuous rain suggest that there is a process of separation of charge within the cloud, such as the ice-friction process, giving a negative potential gradient, and the raindrops falling in this potential gradient acquire a positive charge as described in Wilson's theory. Calculations showing the orders of magnitude of the currents and potential gradients have been given by Chalmers and Little[3]. In order to give an account also of the Eiffel Tower observations, we might add the breaking-drop process occurring near the earth's surface, but difficulties and anomalies remain, and it may be that conditions near the Eiffel Tower are peculiar.

A great deal remains to be done to confirm or disprove the ideas described above; among investigations that would be profitable may be suggested the measurement of rain currents and potential gradients under conditions similar to those of the Eiffel Tower, the measurement of rain currents and point-discharge currents using as discharger one of the trees of a plantation of similar trees, the measurement of potential gradients at various heights with a more sensitive alti-electrograph, and the repetition of Wigand's measurements when rain currents and potential gradients are simultaneously measured.

[1] Simpson, Sir G. C., *Quart. J. Roy. Met. Soc.*, January, 1942.

[2] Simpson, Sir G. C., and Scrase, F. J., *Proc. Roy. Soc.*, A, **161**, 309 (1939).

[3] Chalmers, J. A., and Little, E. W. R., *Terr. Mag.*, **45**, 451 (1940).

[4] Simpson, G. C., *Phil. Trans.*, **209**, 379 (1909).

[5] Wilson, C. T. R., *J. Frank. Inst.*, **208**, 1 (1929).

[6] Gott, J. P., *Proc. Roy. Soc.*, A, **142**, 242 (1933); **151**, 665 (1935).

[7] Wigand, A., *Ann. Phys.*, **66**, 81 (1921).

[8] Chalmers, J. A., *Phil. Mag.* (7), **31**, 363 (1941).

[9] Chauveau, A. B., "Electricité Atmosphérique", **2**, 6 (1925).

OBITUARIES

Prof. B. Malinowski

ANTHROPOLOGY has suffered a great loss by the death of Prof. Bronislaw Kasper Malinowski at Yale on May 16. Holding an international reputation in his field, he was a scientific worker with a subtle and constructive theoretical mind, a teacher who was stimulating to the highest degree, and a man of striking and in many ways most attractive personality.

Born on April 7, 1884, in Poland, Malinowski was first educated at the King Jan Sobieski Public School and later at the University of Cracow, where he graduated Ph.D. *summa cum laude* in 1908. Intending to do research work in physical science, he was prevented by the ill-health which interfered with his work all his life, and later turned to the social sciences, which he studied for a while at Leipzig under Karl Bücher. In 1910 he came to England, and as a student of the late C. G. Seligman began that long association with the London School of Economics and with British anthropology which proved so fruitful for the science he adopted.

At the London School of Economics he became a lecturer in 1913, but went with the Robert Mond Anthropological Expedition to New Guinea in 1914, and carried out field-work there, with intervals in Australia, until 1919. Returning to Europe in 1920, he again took up a post at the London School of Economics in 1921, and remained a member of the staff until his death, being appointed to the newly created chair of anthropology in the University of London in 1927. His links with the United States of America, however, had been many since his first visit there in 1926 at the invitation of the Laura Spelman Rockefeller Memorial. In 1936 the degree of Honorary D.Sc. was conferred upon him by Harvard University, and in 1939 while on leave in America he participated in the teaching at the Department of Anthropology at Yale University, where he became Bernice P. Bishop visiting professor for 1941–42.

As a writer and teacher Malinowski had a profound influence on the development of anthropological thought and research, not only in Great Britain but also abroad. He was not a systematist, and had little interest in the minutiæ of comparative investigation; he attacked, often wittily and sometimes violently, work of historical reconstruction on one hand and of pure technological analysis on the other. But to social anthropology, which he regarded simply as a branch of sociology, he contributed extensively both in methods of research and in fundamental generalizations. His name will always be associated with the "Functional Method", which however much it owed to Durkheim and the school of *L'Année Sociologique*, was by Malinowski re-formulated, developed, christened (complete with capitals) and forged into a powerful instrument for the analysis of cultural relationships and as a basis for a technique of field research. In its broadest sense indeed, under Malinowski's skilful handling, it became not merely a method of studying social phenomena but also an integrative set of generalizations about them and their inter-relations, based upon assumptions about the fundamental drives to human behaviour—in short, it was almost a philosophy of human culture. As such, it invited criticism while it spurred to further investigations. It also awoke interest in circles far beyond those of anthropology alone, bringing into touch studies of social institutions, of political organization, of religion, of technology, and of language.

The stimulus of Malinowski's writings and teaching was manifold. Not since Sir James Frazer has any other anthropologist in Great Britain so struck the imagination of a wide range of readers both here and abroad, by the combination of a vivid rich style, a breadth of treatment and a dramatic subject-matter. His first considerable work, "Argonauts of the Western Pacific", treating of the elaborate ceremonial exchange system of the Trobriand Islanders, and their magic rites, appeared in 1922. This was followed by "Crime and Custom in Savage Society", and "Myth in Primitive Society", in 1926; and "The Father in Primitive Psychology", and "Sex and Repression in Savage Society", in 1927, all based on his long period of intensive research in the same area. In 1929 appeared his best-known work, "The Sexual Life of Savages in North-western Melanesia". His last major publication, "Coral Gardens and Their Magic", appeared in two volumes in 1935. This, less widely read than the other books, is unexampled in its detailed analysis of a primitive agricultural system and its associated ritual; moreover, it contains an elaborate exposition of his theory of meaning in language, especially in magical language, a subject in which he had always a keen interest and to which he made a notable contribution.

As a teacher Malinowski was brilliant, giving of himself unsparingly, and treating his class not as pupils but as co-workers. More and more in later years he tended to abandon the formal lecture for a free discussion in the Socratic style, enlivening it by his flashing wit, and driving home a point in any one of half a dozen European languages to suit the members of the cosmopolitan group usually assembled around him.

But Malinowski's interests were not purely academic. He firmly believed that the test of a science in the last resort is its applicability to practical affairs. He tackled the problem in a systematic way, and in his training of government officials and missionaries and in his work for the International Institute of African Languages and Cultures, and the British Social Hygiene Council, he was one of the first to demonstrate the value of applied anthropology for Colonial affairs.

In all this, his gifts as a scientific worker and a teacher were closely bound up with his personality. To his powerful intellect were allied a great breadth of culture and charm of manner. His emotional hypersensitivity sometimes led him to harsh judgments of men and their motives, but his acute sense of values, his fundamental lack of affectation and his real humanity made his friendship a privilege and gave a richness to all his personal contacts.

RAYMOND FIRTH.

Prof. H. L. Bowman

DR. HERBERT LISTER BOWMAN, who retired from the chair of mineralogy at Oxford in July 1941, died unexpectedly in a nursing home at Oxford on April 22 at the age of sixty-eight.

Born on March 15, 1874, Bowman was educated at Eton College and New College, Oxford, where he took the Final Honour Schools of Natural Science in chemistry in 1895 and in physics in 1896, and proceeded to his M.A. in 1895 and to the D.Sc. degree in 1908. He became attracted to the study of minerals through the teaching of Prof. (now Sir) Henry A. Miers, who had been appointed professor of mineralogy in 1895 in succession to M. H. N. Storey Maskelyne, who had occupied the chair for thirty-nine years.

During the latter part of 1896 and in 1897 Bowman was engaged in research work and also devoted much time to helping in the rearrangement and registration of the mineral collection and in the development of several special exhibits in the Oxford Museum. In 1898 he went to Munich to study under Prof. Groth, and after spending eight months there and in visiting famous mineral collections in Germany and Austria, he returned to Oxford and was appointed demonstrator in mineralogy. During these years he also gave much help in the development and equipment of the Mineral Department at Oxford, which had no laboratory accommodation previous to 1895, and throughout his life he devoted much thought and time in this direction. Bowman was appointed Waynflete professor of mineralogy early in 1909 in succession to Prof. Miers, the appointment carrying with it a fellowship at Magdalen College. The title was altered in 1927 to include crystallography in recognition of the importance of that subject.

Bowman was a very painstaking and accurate research worker and teacher, and those who studied under him will remember his kindness and his patience and the help and advice which he always gave so readily. Most of his published researches deal with the chemical and physical properties of minerals and their modes of occurrence and were published in the *Mineralogical Magazine*, and his keen interest in meteorites is shown in the detailed examination of the Chandakapur and Dokáchi stones which he carried out in collaboration with H. E. Clarke and the results of which are contained in two papers also published in the *Mineralogical Magazine*. He also undertook the revision for the second edition of the standard text-book Miers' "Mineralogy" which was published in 1929.

An ardent collector of minerals, Bowman took part in Oxford expeditions to many English mineral localities, went with the British Association to South Africa and the International Geological Congress to Canada and Sweden. He also visited Switzerland annually for many years, and the Oxford collection is the richer by many specimens collected and presented by him. He inherited a keen interest in music and botany from his father, Mr. J. H. Bowman of Greenham Common, Newbury, and Dr. and Mrs. Bowman had been enthusiastic members of the Oxford Orchestral Society for many years. He also had great mechanical ability, and during the War of 1914–18 he did munition work in Birmingham. He devoted much time and thought to the designing and improvement of apparatus used in his department and introduced many novel experiments into his lectures.

To those who did not know him well, Bowman may have seemed reserved and shy, but he was an extremely kind and unselfish man, always ready to discuss problems and difficulties, and those who knew him intimately will remember him with great affection. He undertook many administrative duties at different times; thus he had served as Recorder of the Geological Section of the British Association, secretary to the Delegates of the University Museum, Oxford, vice-president of Magdalen College and of the Mineralogical Society. This left him little time for research work, but it was his intention, following his retirement, to take up active research again in his old department; his untimely death is a sad blow to his many friends.

In 1921 he married Pleasance Edith, daughter of Mr. James Walker of Kempsey, Worcester (under whom he studied physics in the Clarendon Laboratory at Oxford), and their married life was one of ideal companionship and perfect happiness.

R. C. SPILLER.

IT has been announced that among the Czechoslovak patriots recently executed by the Germans are a university dean and two professors, several secondary schoolmasters and a number of young men described as university students, although the universities have been closed for nearly two years. One of the professors was Prof. Jaromir Šamal, formerly professor of entomology in the Prague College of Agriculture, whose work had considerable local importance through his books in Czech on the anatomy and life-history of insects, on their ecology and their economic importance; Dr. Šamal was forty-one years of age.

WE regret to announce the following deaths:

Captain J. D. S. Pendlebury, formerly curator of Knossos and author of works on the archæology of Crete and Egypt, during the invasion of Crete in 1941, aged thirty-six.

Dr. George A. Reisner, professor of Egyptology at Harvard and curator of the Egyptian Department of the Boston Museum of Fine Arts, on June 6, aged seventy-four.

Prof. James Joseph Walsh, professor of physiological psychology at Cathedral College, New York, and medical director of the School of Sociology at Fordham University, aged seventy-seven.

NEWS and VIEWS

The U.S.S.R. Academy of Sciences and the Royal Society

IN response to a message from the Academy of Sciences of the U.S.S.R., Sir Henry Dale has sent the following reply on behalf of the Royal Society: "The Royal Society of London welcomes the inspiring appeal to the scientists of Britain, made by the members of the Soviet Academy of Sciences at their May conference. We appreciate the great honour bestowed on our President, Sir Henry Dale, and Prof. J. B. S. Haldane, by their election as honorary members of your Academy. The holding of the conference of your Academy at Sverdlovsk is symbolic of the scientific and technical progress made in the newly developed regions of the Soviet Union. We congratulate you on this mobilization of your prodigious resources, which encourages your friends and bodes ill for our enemies. The achievements of your scientists in all fields of research are followed by us with the liveliest admiration. The superb efforts of your countrymen in their resistance to the aggressor would have been impossible, if your technical resources had not been based on a great development of abstract science.

"British scientists likewise have made contribution to the common cause. There has been a growing application of scientific principles to our war effort, and, indeed, to all aspects of our national life. One result of this is to be seen in the remarkably high standard of the health of our people, in spite of ruthless air attacks upon our citizens, and other conditions which might have brought disease. Research has enabled the engineering industry of Britain to make immense advances since the War began. Agricultural research has played its part in reducing the shipping required for the transport of food, and thus releasing more to carry arms and munitions to the Soviet Union. Many inventions made by British scientists have been of decisive importance for the War, such as radio-location, and the device which rendered harmless the magnetic mine. We agree profoundly with you, in the belief that all our technical and scientific resources should be used to the utmost in this War to preserve liberty and democracy. Only thus, as you say, can science itself be saved, and resume its beneficent tasks on behalf of all mankind. Our most earnest and heartfelt hopes are with you in the present and the coming battles, upon the outcome of which the course of history for our countries and for the whole world depends."

Exchange of Scientific Information with the U.S.S.R.

MEN of science in Great Britain now have the opportunity of exchanging scientific communications and inquiries with the U.S.S.R. through official channels. A Conference was recently called at the Royal Society's rooms to discuss the development of contacts between British and Russian scientific workers. A Committee was appointed to examine the possibilities, and its work has been greatly facilitated by the sympathetic attitude of the Embassy of the U.S.S.R. The following procedure has been approved by the bodies concerned. Letters addressed by individual British men of science to individual Russian men of science, or communications from British scientific and technical societies to the corresponding Russian societies, can be forwarded either to: Sir John Russell, F.R.S., Ministry of Information, Malet Street, London, W.C.1, or Mr. J. G. Crowther, The British Council, 3, Hanover Street, London, W.C.1. They will take the necessary steps to forward the communications to the U.S.S.R.

Control of Cattle Diseases

A SCHEME for the control of certain diseases of cattle—mastitis, contagious abortion, sterility and Johne's disease—has been under the consideration of the Ministry of Agriculture for some time. It has the active support of the National Veterinary Medical Association of Great Britain and Ireland and of the National Farmers' Union, and it was brought into operation on June 1. The scheme is voluntary. Farmers wishing to participate are required to enter into an agreement. The Ministry of Agriculture provides free laboratory services for the diagnostic work, free vaccines for bovine brucellosis, and sulphanilamide at a reduced charge. The practising veterinary surgeon undertakes the work on the farm at fees that have been agreed upon. The National Veterinary Association has been pressing for action for some time and has prepared a report detailing the importance of these diseases and showing the extent of the losses they inflict upon the livestock industry in Great Britain. In terms of money, the losses from the first three of the diseases referred to above are estimated to amount to more than £17,000,000 a year. The annual loss of milk due to these three diseases alone (such a serious item in war-time) is estimated to be 198,000,000 gallons.

The position regarding bovine contagious abortion is discussed by F. Francis in the *Veterinary Record* of May 2 (p. 95). He describes the stages in which the essential knowledge of the bovine brucellosis problem has been built up. Much work has been done on the subject in many countries. In suitable circumstances the disease can be controlled by means of a serological test for evidence of infection and the adoption of measures to remove infected animals from the herds. The agglutination test is the most suitable one for this purpose, and it has been used on a large scale throughout the world. Small-scale attempts to control the disease in cattle have been made for more than thirty years and large numbers of herds have been cleared of infection. For this disease, however, the elimination of infection from individual herds is not sufficient; such herds are almost always surrounded by herds in which the organism is present, and they are in great danger of re-acquiring infection. The ideal would be to eradicate the disease on an 'area' basis until ultimately the whole country is cleared. A vast campaign to control bovine brucellosis on these lines has been in operation for some years in the United States and impressive results have been achieved, but it has been found to be costly.

Workers in the United States have developed a vaccine with 'strain 19' of *Br. abortus* which is of reduced virulence, but capable of conferring useful immunity. When young calves contract infection with *Br. abortus* after birth, they usually overcome it completely by the time they reach sexual maturity, and advantage has been taken of this phenomenon. 'Strain 19' has been used in the United States during the last few years for the vaccination of calves, and the reports show good results. McEwen in Great Britain has also developed and tested a strain of low virulence, 'strain 45 (20)'. In laboratory and field experiments he has found that vaccinated cattle acquire a serviceable immunity. The policy now adopted by the Ministry of Agriculture is to use these two vaccines in infected herds in an attempt to reduce the immediate losses. From June 1 no animal in a *TT* (tuberculin tested) herd shall be vaccinated with live *Br. abortus* except with the approval of the Ministry of Agriculture, and only with an approved vaccine. Two approved vaccines are issued by the Ministry of Agriculture, No. 1 (standard) vaccine, which is prepared from the American, 'strain 19', and No. 2 vaccine, which is prepared from 'strain 45 (20)'.

Health Contrasts in the United States

AN article in the March issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company of New York, discusses the difference in health in the United States during the War of 1914–18 compared with that in the present struggle, and comes to the conclusion that America is better prepared now for the hardships of modern warfare than twenty-five years ago. This is shown by the mortality among the industry policy holders of the Company, whose death-rate in the group 1–74 has been reduced slightly more than 50 per cent during the last quarter of a century. The diseases of childhood and infancy such as measles, whooping cough, scarlet fever, diphtheria, diarrhœa and enteritis have been virtually eliminated as causes of death during this period. There has been a considerable saving of life at this early age, and many young persons living to-day have been spared the disabling sequels of these diseases, so that thousands are now available for war service who would otherwise have been rejected. The death-rate from tuberculosis among the policy holders has been reduced by about one fifth. This is of great importance in connexion with the war effort, as many of the sufferers from tuberculosis are between the ages of twenty and fifty to which the great majority of the Fighting Forces belong. The mortality from syphilis, which occurs principally in youth and middle age and tends to increase in war-time, is less than half what it was in 1917. As regards influenza and pneumonia, which caused such heavy losses during 1914–18, the recent researches into the causal agent of the former are encouraging, while the latter, thanks to chemotherapy, has lost much of its terrors.

The increasing industrialization in the United States suggests that there may be an increase in fatal accidents in the near future, but the advance in industrial hygiene and prevention of accidents make it more likely that many lives and working days will be saved which under former conditions would have been lost. Improvement in pre-natal care, obstetric and hospital facilities is shown by the fact that whereas twenty-five years ago more than 17 out of every 100,000 policy holders died in childbirth, to-day this rate is reduced to 5. The great increase in motor accidents since 1917, due to the great increase in number of motor-vehicles, may possibly be mitigated by the curtailment of the supply of rubber and petrol.

Health of the United States Army

ACCORDING to the annual report of the Surgeon-General of the U.S. Army, summarized in the *Journal of the American Medical Association* of April 18, 257,136 men were reported sick from all causes in 1940, giving an annual rate per thousand of 763·3, an increase of 44 per cent over that of 1939, which was the lowest on record. The largest number of admissions was due to respiratory diseases. Then came infectious diseases and diseases of the digestive system. There were 267 admissions with 108 deaths due to aircraft accidents in 1940, and 32 deaths from accidental drowning. The admission for venereal diseases was 42·5 per thousand, and the number of days lost due to this cause 456,148. The average number of men absent from duty each day for venereal disease was 1,246 and the average length of treatment was 52 days. The average number of days lost for syphilis was 28, for gonorrhœa 35 and for other venereal diseases 20. During the year, 1·39 per cent of the strength of the army was lost by discharge or retirement for physical disability. Dementia præcox was the chief cause for discharge. Tuberculosis reached a new low level. There were 229 deaths attributed to motor accidents.

Electrically Driven Excavators

IN a paper given before the Institution of Electrical Engineers on May 14, P. H. R. Durand points out that the electrically equipped single-bucket excavator is employed extensively in the quarrying of rocks such as limestone and chalk for cement manufacture, ironstone and other minerals and also for excavating granite, sand and gravel, clays and shales. Large installations are used in the open-cast mining of coal. These machines are also used sometimes around industrial works for handling materials such as blast-furnace slag. In some quarries the excavator provides raw material which is processed in an adjoining factory and for which there may be limited accommodation prior to processing. The excavator is here the starting-point of a mass-production unit, its rate of output being measured by the hour instead of by the week or month, and in applications of this type it must be regarded as an automatic machine. The author describes the sphere of application of the excavators and, in commenting on the increasing importance of electric drive, gives an explanation of the fundamental motions and structural limitations of the machines.

A summary of the special service conditions precedes a discussion on electric drive methods for the two main groups of excavators, the 'friction' type and the individual-drive machine, where the application of the modern Ward-Leonard system with 3-coil dynamo and separately excited motor is referred to in some detail. Main and auxiliary equipment is described from the electrical and mechanical aspects, and installation and wiring details are supplemented by illustrations of typical equipment layouts and wiring diagrams. Attention is directed to certain special aspects of power supply and distribution to excavating projects, representative power consumptions being given. The scope of the paper is limited by present circumstances, no reference being made to Continental or overseas practice, or to the dipper dredge, which, possessing an operating cycle similar to that of shovel excavators, is equipped with motors and control of equivalent characteristics. Illustrations are confined to the smaller machines, since up to the present time the scope of excavating operations in Great Britain has not stimulated any demand for the larger machines except for stripping shovels to remove deep overburden in the ironstone mines.

Prevention of Blindness

THE March issue of the *Boletin de la Oficina Sanitaria Panamericana* gives the following list of international societies for the prevention of blindness: The International Society for the Prophylaxis of Blindness was organized in 1929 under the presidency of the late Dr. Félix de Lapersonne, professor of ophthalmology in the Paris Medical Faculty, and held several meetings in various European capitals, the last being in Cairo in December 1937 in conjunction with the Fifteenth International Congress of Ophthalmology. Its office is at 66 Boulevard St Michel, Paris 6^e. In 1930 it became united with the International Organization for the Campaign against Trachoma, the organ of which is the *Revue internationale de Trachome*. Other international societies of the kind are the International Association for Blind Students, 1 Rue Etienne Dumont, Geneva, and the Spanish-American Association for the Blind, 1545 Madison Avenue, New York. Reference may also be made to the International Council of Ophthalmology, Rotterdam, and the International Federation of Ophthalmologic Societies.

Bibliography of Seismology

THE *Bibliography of Seismology* for the period July–December 1941, prepared at the Dominion Observatory, Ottawa, by Mr. Ernest A. Hodgson (now president of the Seismological Society of America), has just been received. It covers 145 items, ranging through pure and applied seismology, building construction, cosmogony, engineering, instruments, insurance, oceanography and time-keeping. About forty-five items deal with seismic prospecting and patents associated with it, and forty-two items deal with instruments, chiefly for the detection of various types of natural and artificial seismic waves. Items in NATURE are listed. Several items deal with seismic surveying in the U.S.S.R. (for example, "Prospects of Seismic Survey by the Method of Refracted Waves in the Region of Ust-Eniseisk Port" by R. M. Demenitskaia, Problemi Arktiki, No. 5, 81–92, Leningrad, 1939), and it is not known whether or not the War has interfered with many of these projects. From time to time luminous phenomena have been reported as accompanying seismic phenomena, and one such is listed: "Sur les phénomènes lumineux qui ont accompagné le tremblement de terre de Roumanie du 10 novembre 1940", G. Demetrescu and G. Petrescu, Académie Roumaine, Bulletin de la Section Scientifique, Tome 23, No. 6, pp. 5, 1 chart, Jan., 1941."

"Thorpe's Dictionary of Applied Chemistry"

FIVE volumes of the current edition of "Thorpe's Dictionary of Applied Chemistry" were published under the editorship of Sir Jocelyn Thorpe and Dr. Martha A. Whiteley. With the death of Sir Jocelyn Thorpe new editorial arrangements have been necessary, and in order to maintain a balance between the various branches of chemical science, an editorial board has been formed, comprising Prof. I. M. Heilbron (professor of organic chemistry and director of the Laboratories for Organic Chemistry at the Imperial College) (chairman), Prof. H. J. Emeleus (assistant professor and reader in inorganic chemistry at the Imperial College), Prof. H. W. Melville (professor of chemistry in the University of Aberdeen), and Prof. A. R. Todd (Sir Samuel Hall professor of chemistry and director of the Chemical Laboratories in the University of Manchester). This Board will determine the general editorial policy in conjunction with the publishers. Dr. Whiteley continues as editor, and Dr. A. J. E. Welch (assistant lecturer in inorganic chemistry at the Imperial College) becomes assistant editor; thus the association with the Imperial College is being maintained. Vol. 6 of the current edition is in the press, and it is proposed to complete the edition with eight further volumes, published at yearly intervals. Although the Board does not consider that any major modification of the general character of the work is required, certain changes in the scope of the articles, particularly with regard to physical chemistry topics, are to be made.

Announcements

THE University of Marburg, with the support of the Behring Works, has founded an Emil von Behring prize consisting of a medal and a sum of five thousand gold marks. It will be awarded every two years for scientific work in medicine, veterinary medicine or natural science, with special reference to immunity and control of epidemics.

UNDER the title "Why I am a Rationalist: Books which have Influenced Me", Messrs. C. A. Watts and Co., Ltd., have published for the Rationalist Press Association, Ltd., a series of autobiographical essays which originally appeared in the "Literary Guide". The contributors include the Right Hon. Lord Snell, Prof. J. B. S. Haldane, Marjorie Bowen, Prof. H. Levy, Ivor Brown, W. B. Curry, and others. The contributions are of varied merit but form a useful, if scarcely critical, guide to a wider range of literature than can fairly be claimed by rationalism as its own. The book may well direct readers to books which to-day do not receive the attention they deserve.

THE tenth annual Summer Conference on Spectroscopy and Its Applications, arranged jointly by the Optical Society of America and the Massachusetts Institute of Technology, will be held at the latter during July 20–22. A symposium on fluorescence and phosphorescence is planned in connexion with the Conference. Admittance to the Conference will be by reservation as usual. Further information and tickets can be obtained from Prof. George R. Harrison, Massachusetts Institute of Technology, Cambridge, Massachusetts. The usual courses in spectroscopy will not be given at the Massachusetts Institute of Technology this summer.

Prof. M. Polanyi and Mr. A. G. Evans write: We wish to supplement our letter entitled "Calculation of Steric Hindrance" (NATURE, May 30, p. 608) by the following footnote which was attached to the letter in proof, but was not received in time to be printed: The presence of steric hindrance in the case of neopentyl has been briefly pointed out by Hughes (*Trans. Far. Soc.*, 623; 1941) on what seem to be similar lines. He, however, interprets the slowness of reactions of the type (1) for *t*-butyl halides on a different basis. See also a recent paper by Bartlett and Rosen (*J. Amer. Chem. Soc.*, 64, 543; 1942) on steric hindrance in neopentyl halides.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Nutrition and the War

I WOULD like to thank Dr. Kon for his kind remarks about my book[1] in his review in NATURE[2], and for his critical comments, which, coming from a person of his standing in the nutritional world, are of considerable value to me. I would like, however, to comment on some of the statements which he has made.

On p. 82 of my book, immediately preceding the food tables, I state, "It will probably be noticed that peas, beans and lentils are good in almost every constituent, but it should be remembered that we eat relatively small quantities of them at a time so that in their case the appraisement may be a little misleading. In the case of potatoes, which are listed as poor in calories, they may constitute a significant proportion of one's calorific intake if enough of them is eaten." In view of this statement, I feel that Dr. Kon is unjust in his comment that there is "a lack of appreciation that it is not so much the richness of a product in any given food factor as the amount consumed that matters in the end".

Dr. Kon points out that this lack of appreciation has led to the "strange selection of curry powder as the best source of iron". McCance and Widdowson[3], to whom incidentally Dr. Kon refers me, state on p. 9 of their report, "Curry powder contained more than three times as much iron as any other food (75 mgm. per 100 gm.)". That curry powder is so rich in iron that the amount used in making a meat curry is sufficient to secure an important increase in the amount of iron eaten can be seen from the figures given below (McCance and Widdowson[3], p. 103).

Beef stew	..	2·49 mgm. of Fe per 100 gm.
Curried meat	..	4·70 ,, ,, ,, ,, ,, ,,

In the circumstances I do not agree with Dr. Kon that my selection of curry powder as the best source of iron is a strange one.

In mentioning my reference to the food value of ethyl alcohol, Dr. Kon refers to this "misinterpretation of Mitchell's work". I purposely made no attempt to interpret Mitchell's work and gave only a plain statement of fact. A comparison of the following two statements will make this clear:

From Mitchell's paper[4], p. 333. "The energy of ethyl alcohol is to a large extent available for physiological purposes. Added to a complete diet such as milk it induces more rapid growth and greater retention of nitrogen as well as fat."

From my book, p. 136. "Dr. H. H. Mitchell . . . found that rats fed on a diet adequate in the known nutritional factors and to which a small daily allowance of alcohol had been added, grew faster and retained fat and nitrogen to a much greater extent than other animals which received the diet without the alcohol."

G. BOURNE.

University Laboratory of Physiology,
Oxford.

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[1] Bourne, G., "Nutrition and the War", second edition (Cambridge University Press, 1942).

[2] Kon, S. K., NATURE, **149**, 453 (1942).

[3] McCance, R., and Widdowson, E. M., *Special Report*, No. 235, *Med. Res. Coun.* (1940).

[4] Mitchell, H. H., *J. Nutrition*, **10**, 311 (1935).

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(1) I STILL feel that, in a popular book on nutrition, great care should be exercised in giving the reader guidance on the best choice of practical sources of supply of different nutrients, and I still think that Dr. Bourne's tables do not give such guidance. The value of curry powder as a practical source of iron for the population of Great Britain is, in my opinion, nil.

(2) The food value of ethyl alcohol. Mitchell's experiment showed that when alcohol was added to a certain diet its energy was available for physiological purposes, but that it was only three quarters as available as that of a similar supplement of sugar, which caused greater retentions of nitrogen and energy. Dr. Bourne's description makes no mention of the comparison of alcohol and sugar and conveys the impression that alcohol exerts a specific beneficial effect on the deposition of fat and utilization of food nitrogen. It tells the truth but not the whole truth, and in this way it certainly misinterprets Mitchell's findings.

S. K. KON.

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Amino Acids and the Human Being

THE satisfaction which may quite legitimately be felt in the logical and painstaking work which enabled Rose to classify the amino acids into essential and non-essential groups rather dims the realization that his classification only refers to the needs of the growing rat. In his recent communication to NATURE, Mr. Bacharach[1] gives a welcome jolt to the complacent attitude, so easily adopted, of assuming that what is true of the growing rat is true not only of the adult rat, but also of other species of animals. The work of Wolf and Corley[2], and of Burroughs, Burroughs and Mitchell[3], has shown, however, that the amino acids required to maintain nitrogen equilibrium in the adult rat are not entirely the same as those needed to make the young rat grow. These results illustrate the necessity of qualifying the term 'essential' when it is applied to amino acids.

Although about six years have elapsed since Rose made his classification of amino acids into essential and non-essential groups, our knowledge of the requirements of other species of animals is distressingly meagre. The sum total of our knowledge appears to be that the adult dog probably requires the same amino acids as the adult rat for the maintenance of nitrogen equilibrium, that in the regeneration of plasma protein in dogs with experimental hypoproteinæmia, cystine, leucine and glutamic acid are of primary importance, that the chick requires tryptophane, histidine, methionine, and (most surprisingly) glycine for growth and arginine for both growth and maintenance, and that lysine is required by cattle for both maintenance and milk production. What other amino acids are required by the chick and by cattle have not been elucidated.

Mr. Bacharach points out that it would be interesting to know what evidence there is indicating the indispensability or dispensability of individual amino acids for humans. At the end of last year Holt and his co-workers[4] showed that human subjects on diets deficient in tryptophane or lysine develop negative nitrogen balances which can be restored to normal by supplying the specific amino acid. No other evidence of this nature exists so far as I am aware: indeed only Sharpenak and his colleagues[5] have hitherto shown any active interest in the question of the amino acid composition of human flesh, and of the combination of natural foodstuffs which would supply these amino acids in the required proportions. It is unfortunate that although more refined methods are now available for the determination of amino acids in proteins, no further work has been done on these lines.

Supplies of protein foods for both the human and the stock populations of Great Britain are limited, and this limitation will continue after the War. For the most economical use of these supplies it is obviously of the utmost importance for us to determine as rapidly as possible the qualitative and quantitative amino acid requirements of farm animals and man.

WM. E. GAUNT.

203 Hood House,
Dolphin Square,
London, S.W.1.
May 15.

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[1] NATURE, 149, 473 (1942).

[2] *Amer. J. Physiol.*, **127**, 589 (1939).

[3] *J. Nutrition*, **19**, 363 (1940).

[4] *Proc. Soc. Exptl. Biol. Med.*, **48**, 726, 728 (1941).

[5] *J. Physiol.* (U.S.S.R.), **17**, 170 (1934).

Ancestry of Captorhinomorph Reptiles

IN a review of Tetrapod origins[1] I have mentioned certain results of comparisons of early Reptilia and Amphibia of which a full account must await less abnormal circumstances. Meanwhile it seems desirable to outline some of the conclusions.

The Seymouriamorpha and Diadectomorpha, reptiles of Permian age, are often considered to include ancestors of the other reptilian groups. But the geological history of the Captorhinomorpha and their Pelycosaur relatives goes back well into the Stephanian[2], and Captorhinomorphs may possibly include also the ancestors of Diapsid reptiles. It is therefore of considerable interest that they cannot be derived from Seymouriamorphs, nor apparently from Diadectids.

The well-known Captorhinomorphs are comparatively late (Captorhinus, Labidosaurus are Clear Fork = Artinsk). They have very specialized temporal regions, and the bone nomenclature is controversial. But Pelycosaurs, which are certainly derived from early Captorhinomorphs, show a primitive condition (seen also in Diadectes, etc.) in which the supratemporal lies in the skull-table and meets the postorbital; the supratemporal also turns down to lie near the paroccipital process, from which it is separated by the tabular, here a bone of the occipital surface[2]. Comparison of the series Ophiacodon—Eothyris (both Pelycosaurs)[2]—Protorothyris—Romeria (both Captorhinomorphs approaching Pelycosaurs)[3]—Captorhinus shows that the supratemporal is easy to follow throughout. In Captorhinus it is the small flake on the skull-table, often called tabular; in Labidosaurus Williston shows the bone to be absent. In both forms the tabular, if present, must lie on the occipital surface. It is clear that the supratemporal is greatly reduced in the late Captorhinomorphs; early members should have had large supratemporals meeting the postorbitals, with tabulars and postparietals (= dermosupraoccipitals) on the occipital surface, and the otic notch largely obliterated by downward rotation of the paroccipital process, tabular and supratemporal. Such a type could be ancestral to known Captorhinomorphs and Pelycosaurs, and is in sharp contrast to Seymouriamorphs. The Diadectomorph structure is not dissimilar.

This primitive Captorhinomorph structure compares exactly with that of the uppermost Westphalian "Adelospondyl Amphibian" Microbrachis and its apparent relative Hyloplesion (which shows that the bone in Microbrachis called 'tabular' is the supratemporal[4]), and with no other known Amphibia. These forms show marked resemblance to Captorhinomorphs in the structure of the whole skull and palate, rather similar vertebræ, ossified caudal intercentra bearing hæmal arches (unossified intercentra may possibly have occurred elsewhere), somewhat similar arrangement of ribs, etc. The limb skeleton is not too well known in the Nýřany Microbrachids, where the hand is apparently reduced to three digits. The digital formulæ of the feet of Microbrachis and Hyloplesion are 2, 3, 4, 4, 3 and 2, 4, 5, 3, 1 respectively. It is clear that these forms are too specialized (degenerate ?) to be actual Captorhinomorph ancestors; but it is highly probable that the contemporaneous Linton (Ohio) forms *Tuditanus punctulatus* (Cope) (= *Eosauravus copei* Will.) and *Eusauropleura digitata* (Cope)[5] are closely related to them (they correspond well in other ascertainable characters to Microbrachids) and these show respectively the digital formulæ (foot), 2, 3, 4, 5, 4 and (hand) 2, 3, 4, 5, 3. Several other Microsauria show remarkably reptile-like characters, involving limb-girdles, vertebral structure, hæmal intercentra, presence of entepicondylar foramen in humerus, etc. (for example, Hylonomus, Fritschia)[6].

It seems very probable, therefore, that the ancestry of the Captorhinomorpha is to be sought among small Carboniferous vertebrates which Moodie would have included in his Microsauria and are now usually regarded as Adelospondyl or Lepospondyl Amphibia. (Recent experience has made the neurocentral suture an unreliable character for separating Adelospondyli and Lepospondyli[7].) Moodie, long ago, suggested that *all* reptilia originated from the Microsauria, a view held by others of the older workers, and Goodrich also noted reptilian characters in the caudal intercentra of Hylonomus, and regarded the Microsauria as reptiles. The remarkably annectant characters of Seymouria have diverted attention from the smaller forms, and Seymouria was certainly derived from Anthracosaurid Embolomeri[8]. Diadectes seems to be a somewhat isolated type, of which the ancestors cannot yet be indicated, though in many details it resembles Captorhinomorphs. The cranial pattern and general similarity of body structures show that Seymouriamorphs, Captorhinomorphs and Diadectomorphs could only be derived ultimately from Anthracosaur-like Stegocephalia. Pantylus, as suggested by Säve-Söderbergh, should be removed from Cotylosauria; I hope to comment further on this interesting form and its relatives.

The Cotylosauria may therefore be regarded as springing ultimately from a fairly well-defined stock, but the differentiation along at least two of the three main lines occurred while the animals were still technically Amphibia. Säve-Söderbergh's term Reptiliomorpha[9] is useful to cover the Anthracosaurs and the Cotylosaur groups, and should also include the smaller animals discussed above; some of the other Carboniferous smaller Amphibia (Nectidia, Aistopoda) may possibly be nearly related.

Marischal College,
University of Aberdeen.
May 19.

T. S. WESTOLL.

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[1] *Biol. Rev.* (in the press).

[2] Romer and Price, "Review of the Pelycosauria", Geol. Soc. Amer. Spec. Papers No. 28 (1940).

[3] Price, L. I., *Proc. New Zealand Zool. Club*, **16**, 97 (1937).

[4] Steen, M. C., *Proc. Zool. Soc. Lond.*, **108B**, 205 (1938).

[5] Romer, A. S., *Bull. Amer. Mus. Nat. Hist.*, **59**, 77 (1930).

[6] Steen, M. C., *Proc. Zool. Soc. Lond.*, 1934, 465 (1934).

[7] Moodie, R., *Geol. Mag.*, **6**, 216 (1909).

[8] White, T. E., *Bull. Mus. Comp. Zool. Harv.*, **85**, 325 (1939).

[9] Säve-Söderbergh, G., *Medd. Grønland*, **98**, Nr. 3 (1935).

Mitotic Divisions following Meiosis in *Pediculus corporis* Males

MANY years ago one of us[1,2] found that the offspring of single-pair matings of the body louse, *Pediculus corporis*, are often all of one sex, and that even when both sexes are represented among the offspring of one pair there may be a significant preponderance in the numbers of one or the other sex. Data since collected have confirmed and extended these observations, and also shown that differential mortality does not account for these unusual sex ratios, but hitherto no satisfactory explanation has been found of the method of sex determination. During our attempts to find out the mechanism involved, the process of spermatogenesis has been reinvestigated, and the results obtained, although at present throwing no light on the main problem, seem of sufficient interest to be recorded.

In *P. corporis* the somatic cells of both sexes, and also the oogonia and spermatogonia, contain six pairs of extremely minute chromosomes. So far as can be seen, five pairs have a median, and one a terminal centromere. We have not been able to distinguish any dimorphic pair.

In the embryo meiosis starts before hatching and continues at least during all three nymphal stages; spermatogonial divisions can be seen throughout the same period. It will be understood from what follows why meiotic divisions, as well as spermatogonial divisions, are so rare as to have escaped notice by previous workers[3,4].

The spermatogonia ($2n = 12$) undergo meiosis singly without the preliminary growth-phase usually occurring in spermatocytes. There are five bivalents and two univalents in the first division. The second division, even more rarely seen than the first and therefore very rapid, in the metaphase plate shows six chromosomes, five arranged peripherally, and one in the centre. This arrangement is repeated in the five subsequent mitoses described below.

The four haploid products of meiosis, each much smaller than the original spermatogonium, undergo four successive mitotic divisions in perfect synchronization, forming successively cysts of 8, 16, 32 and 64 cells. After the 64-cell stage has been reached, a certain amount of growth takes place and a large spherical mitochondrial body makes its appearance. A fifth mitosis follows, of a very peculiar type, accurately described by Doncaster and Cannon[3,4]. One of the daughter nuclei with very little cytoplasm and no trace of the mitochondrial body is extruded at telophase; while the other daughter-nucleus, together with practically all the extra nuclear material, including the mitochondrial body, begins its transformation into a spermatozoon. Hence there are only 64 spermatozoa in each bundle.

It will be seen, therefore, that in Pediculus the phase of multiplication of the germ cells which usually precedes meiosis takes place in part after meiosis; in other words, meiosis is pushed back in the development of the germ track. So far as we are aware, the only comparable case known among the higher animals and plants is that of the haploid testes in the diploid hermaphrodite coccid, *Icerya purchasi*.

Department of Zoology,
University of Glasgow.
May 26.

E. HINDLE.
G. PONTECORVO.

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[1] Hindle, E., *Parasitology*, **9**, 259 (1917).

[2] Hindle, E., *J. Genet.*, **8**, 267 (1919).

[3] Doncaster, L., and Cannon, H. G., *Quart. J. Micro. Sci.*, **64**, 303 (1920).

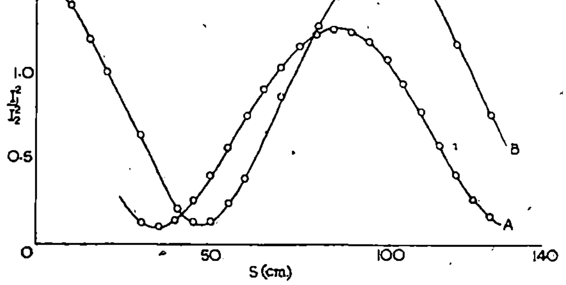
[4] Cannon, H. G., *Quart. J. Micro. Sci.*, **66**, 657 (1922).

Input Impedances of Vacuum Thermo-junctions at Ultra-High Frequencies

THE method of analysing impedances at ultra-high frequencies using Lecher wires, recently described by Flint and Williams[1], has been used to examine a number of thermojunctions the D.C. heater resistances of which varied between 100 and 1,600 ohms. The frequency employed was approximately 150 Mc./sec.

The input impedances were measured with the junctions mounted in pin bases secured in valve-holders and also when demounted and connected directly to the Lecher wires. The latter method removed the substantial capacitative effect inherent in the external mounting, but left the capacities within the pinch and also the self-capacity and self-inductance of the spiral filament. At the above frequencies these residuals have an admittance comparable with that of the filament.

If the thermo-junction is used to terminate the transmission line, a change in its reactance will change the phase angle in the reflexion coefficient. This will be accompanied by a shift in the standing wave system which is set up.



The shift produced by demounting a junction (D.C. filament resistance, 1,500 ohms) is shown in the accompanying figure. Curve *A* was obtained with the junction mounted and curve *B* when demounted.

Calculations for the various junctions available are summarized in the table below. *R* denotes the D.C.

D.C. Resistance R (ohms)	H.F. Series Components				H.F. Parallel Components				M_p (pf)	N_p
	R_s (ohms)		X_s (ohms)		R_p (ohms)		X_p (ohms)			
	Mounted	Demounted	*M*	*D*	*M*	*D*	*M*	*D*		
90	105	—	+76	—	160	—	+ 221	—	—	—
410	414	540	−13·7	+ 69	414	549	−1250	+4300	1·03	4·6 μH.
1500	320	994	−439	−394	922	1150	− 673	−2900	1·21	0·36 pf
1600	335	1140	−432	−570	892	1425	− 692	−2850	1·16	0·37 pf

resistance of the filament; R_s and X_s are the series resistive and reactive components of the input impedance, while R_p and X_p are the equivalent parallel components; M_p denotes the capacity introduced by the mounting and N_p the net residual inductance or capacity of the demounted junction.

These results show:

(1) That the residuals in this type of junction are inductive for low values of R (X is positive), but are capacitative for the higher values (X is negative). This is believed to be a net effect with the self-capacity increasing more rapidly with the length of the spiral than does the self-inductance. Thus for the junctions of higher resistance this increased self-capacity more than nullifies the rise in the resistive component due to the skin effect and to the self-inductance. For these, R_p is less than the D.C. value.

(2) That the demounting of the junction corresponds to the removal of a shunt capacity of approximately 1·1 pf., leaving only the residuals.

They demonstrate, therefore, the importance of an individual analysis of a thermo-junction if it is to be successfully matched into any circuit.

The current responsible for heating the filament is a fraction of the total current through the junction assembly. This fraction depends on both the applied frequency and the construction of the junction, but our results indicate that it is independent of the magnitude of the current. The response of the junction at ultra-high frequencies is thus proportional to the D.C. calibration curve, which may, therefore, be used in the interpretation of radio-frequency currents. This calibration curve is rarely linear, so that for accuracy reference should always be made to it.

D. ROGERS.
GORDON WILLIAMS.

King's College, London,
at H.H. Wills Physical Laboratory,
University, Bristol, 8.
May 22.

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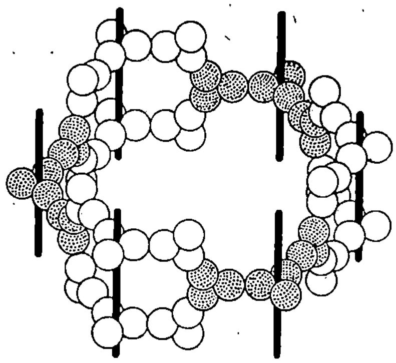
[1] Flint and Williams, *Phil. Mag.*, (7), 32, 489 (1941).

Open Packing of Spheres

TAKE four equal spheres with diameter d and place one at each vertex of an equilateral triangle the sides of which are $2d \cos 30°$ in length: the fourth sphere placed at the centre of the triangle will make contact with the first three. Call this set of four spheres a structural unit. Next draw a regular hexagon with sides $2{\cdot}5d$ in length. At alternate vertices of the hexagon place a structural unit with its centre coinciding with the vertex, and two lines of centres from the middle sphere coinciding with two sides of the hexagon. Construct a second sheet of units with their centres over the remaining vertices of the hexagon, corresponding lines of centres overlying the remaining sides of the hexagon. Add a third sheet the same as the first and overlying it: and a fourth the same as the second overlying the second, and so on.

In the resulting structure (which has a density of 0·149) the lines of centres from any sphere to those touching it make angles of 120°, and therefore Heesch and Laves's *Ersetzungsprinzip*[1] can be applied to it. This consists in substituting a group



of three spheres (in mutual contact) for every sphere in the original structure. In this way we arrive at the system shown in the accompanying figure. This structure has a density of 0·045 and a higher degree of homogeneity than that recently described[2].

Yorkshire Museum,
York.

SIDNEY MELMORE.

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[1] Heesch, H., and Laves, F., *Z. Krist.*, 85, 443 (1933).

[2] Melmore, S., NATURE, 149, 412 (1942).

Catalytic Dimerization of Isobutene by Activated Copper Sulphide

IN previous communications[1] it has been shown that copper sulphide, activated by oxidizing a part of its surface into copper sulphate, is a catalyst for the low molecular polymerization of isobutene. It has now been found that the main product of the catalytic process is a mixture of the two 2 : 2 : 4-trimethylpentenes which on hydrogenation were converted into 2 : 2 : 4-trimethylpentane. This latter compound was identified by determining the boiling point, the specific gravity, the refractive index, the melting point and the mixed melting point with an authentic sample. A detailed description of the experiments will be published elsewhere.

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W. T. WELLER.

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[1] Wassermann, British Patent 499953; Ingold, E. H., and Wassermann, A., *Trans. Farad. Soc.*, 35, 1022 (1939).

RESEARCH ITEMS

Fruitflies of the Genus Anastrepha

MISCELL. PUB. 839 of the United States Department of Agriculture (Washington: Govt. Printing Office. 40 cents) is devoted to the above subject. In about a hundred pages the author, Alan Stone, contributes a more or less complete systematic monograph on the genus in question. Certain of its species in their larval stages damage the fleshy parts of subtropical and tropical fruits of various kinds. Six species are at present recognized as being of major economic importance in the western hemisphere, where they damage such fruits as citrus, mango, guava, peach, etc. The range of the genus is from South America, into tropical Central America and the West Indies together with southern Florida; also a few species are Mexican. The author recognizes 126 presumably valid species, and in the accompanying key the females only are dealt with. The apex of the ovipositor is figured in many cases since it affords characters of recognized value. Difficulties, apparently insuperable at the present time, preclude the preparation of a similar key to the males. The early stages are not dealt with, since they are known for so few of the species.

Indian Fishes

IN a lecture delivered to the Royal Asiatic Society of Bengal on March 25, 1941 (*J. Roy. Asiatic Soc. Bengal,* Science, 6, Article No. 10; 1940), Sunder Lal Hora gives interesting information on the life-history and wanderings of Hilsa in Bengal waters. *Hilsa elisha,* allied to the herring, is a valuable marine fish the periodic ascent of which into fresh waters has earned it the name of the Indian shad. Dr. Hora has already published papers on his researches on the spawning grounds and bionomics of this fish (*Rec. Ind. Mus.*, 40, 42), but the present paper is valuable in bringing together in simple language all that is known, with comments on the fishery. It is only quite recently that it was found positively that Hilsa spawns high up in the rivers. A series of papers on fishes by the same author is published in the *Records of the Indian Museum* (43, Part II; 1941), in the *Journal of the Bombay Natural History Society* (42, No. 2; 1941) and the *Journal of the Royal Asiatic Society of Bengal,* Science, 6; 1940, 1941). These include descriptions of the freshwater fish of Travancore and a continuation of former work on the same fishes of India.

Intertidal Sand Fauna

E. EMRYS WATKIN ("The Macrofauna of the Intertidal Sand of Kames Bay, Millport, Buteshire" *Trans. Roy. Soc. Edinburgh,* 50, Part II, No. 16; 1942) has continued the studies carried on by Elmhurst and Stephen (1928–31) and now attempts a more precise statement of the zonation by fixing stations at much narrower intervals, actually 5 yards apart, giving 42 stations over a horizontal range of 210 yards, from high-water spring tides to low-water spring tides. The groups of animals represented are chiefly Crustacea and Polychæta and the very abundant lamellibranch *Tellina tenuis.* On the whole, the Crustacea are more sharply zoned than the Polychæta, with each species showing a more definite centre of abundance. Compared with other bays, the zonation is usually similar, although a few definite exceptions occur. Special attention is paid to the size of the soil particles, and a mechanical analysis is made of these which shows that the soil is very even over the whole tidal range, with particles of a size 0·2–0·5 mm. accounting for more than 80 per cent of the samples. Comparison with the analysis of soils by other workers shows that this composition carries high population densities. The author points out that the grade composition of the soil appears to affect density directly, but it cannot account to any extent for the zonation of the organisms, and the factors governing zonation are still problematical and differ from species to species.

Relative Firmness of Pig Back Depot Fat

IN a paper by W. Bolton and R. G. Baskett read at a meeting of the Society of Public and Other Analytical Chemists on May 6, the iodine value as an index of the relative firmness of pig back depot fat was considered. For pig back depot fat a close correlation was found to exist between the iodine value (Wijs) and the firmness as measured by means of the grease penetrometer of the Institute of Petroleum. The firmness measurements were carried out at 30·5°, 32·0° and 46·5° F., at which temperatures the average depths of penetration were 4·5, 6·4 and 15·3 mm. The correlation coefficients between iodine values and depths of penetration were + 0·9564 (23 samples) at 30·5°, + 0·8543 (28 samples) at 32·0°, and + 0·7136 (28 samples) at 46·5° F. In laboratories where the close temperature control necessary for penetrometer or similar direct tests of firmness are impracticable, the iodine value will give a more accurate measure of the firmness of these fats.

Temperature and Sex Ratio in *Drosophila pseudo-obscura*

MALES of *Drosophila pseudo-obscura* and several other species of Drosophila exhibit the genetical character 'sex-ratio' by giving more than 90 per cent females in their progeny, no matter what female is used as mate. C. D. Darlington and Th. Dobzhansky (*Proc. Nat. Acad. Sci.*, 28, 45; 1942) give evidence which suggests that the X-chromosomes in these males divide twice instead of once at meiosis. As a result the majority of the spermatids contain an X-chromosome. The abnormal behaviour induced by a gene appears to depend on an excessive charge of nucleic acid, and, therefore, the authors expected the effect could be influenced by temperature as in other organisms. They find that there is a significant increase of males in the progeny of males kept at 16° C. as compared with those kept at 25° C.

Rainfall in South Madras

SCIENTIFIC Note No. 98 of the India Meteorological Department by V. Doraiswamy Iyer is devoted to the forecasting of the north-east monsoon rainfall of the south of Madras by the methods developed by Walker and others. The south-east of India, which is agriculturally important, receives comparatively little rain in the main wet monsoon period, June–September, and gets the bulk of its annual fall during October, November and December, when the south-west monsoon is retreating from India and when the rain-bearing winds on the Coromandel coast are north-easterly winds that have passed round the seasonal low-pressure area south of the Bay of Bengal. The formulæ developed in this investigation were arrived at after preliminary studies of the correlation coefficients between the rainfall of these months in the different sub-divisions of the province of Madras had shown that the south-east of Madras and Malabar can usefully be combined into a single region for forecasting. The rainfall of this region, which may be called "South Madras" was then studied in relation to various meteorological elements at action centres in other parts of India and further afield, and the formula arrived at was:

> South Madras Rain = − 0·39 (S. America pressure June–Aug.) − 0·38 (Bangalore westerly winds at 3–5 km. height, Sept.) + 0·21 (Agra westerly winds at 5–8 km. height, Sept.)

This formula has a multiple correlation coefficient of 0·60. The formula for south-east Madras rainfall alone, using the same variables, was found to have only slightly different numerical factors, these being −0·38, −0·37 and +0·22, and, as was to be expected, the multiple correlation coefficient is nearly the same, being 0·59. Graphs of actual and calculated falls during 1914–1940 are given, followed by a discussion of the meteorological peculiarities of some of those seasons when the agreement between the two curves was not good. One might reasonably suppose that a study of such forecasting failures, if certain abnormalities of the meteorological regime were found to be a recurrent cause of failure, would give an indication of one or more additional variables that should have been included in the formula, but this enticing line of inquiry was apparently not followed up.

Extra Reflexions of X-Rays from Diamond

NEW experimental facts about the reflexions of X-rays by diamond have recently been published with reproductions of the X-ray photographs by Kathleen Lonsdale (*Proc. Roy. Soc.*, A, 179, p. 315; 1942). Two kinds of extra reflexions can be seen on well-exposed Laue photographs. All diamonds show *primary* diffuse reflexions, which are temperature-sensitive but not structure-sensitive. Type I diamonds, only, show *secondary* reflexions (sharp spots, streaks and groups of spots which are not at all typical of diffuse spots in general). They are no more than slightly, if at all, temperature-sensitive and are strongly structure-sensitive. *Primary* and *secondary* reflexions have been observed for many diamonds and in various orientations, associated with the {111} {220} {113} {331} Laue reflexions, using filtered and unfiltered radiation from copper and iron targets. No adequate explanation is yet available of the *secondary* reflexions, taking into account their structure-sensitiveness, the presence of {220} spots and the apparent incompleteness of the groups of spots actually observed.

Space-Charge and Electron Beams

AN informative article by D. P. R. Petrie (*Electrical Communication*, 20, No. 2; 1941) on the effect of space-charge on the potential and electron paths of electron beams presents the more important results of analyses of space-charge in electron streams collected from existing literature, giving them in the form of curves and nomograms suitable for ready application in practice. The effects considered are the space-charge limited current in plane and cylindrical diodes; the minimum potential; maximum current and increase of transit time in the screen - anode region of tetrodes; and the minimum potential, maximum current, velocity distribution and divergence of a long, flat beam between parallel plates and of a long, cylindrical beam in a tube. When an electron stream passes through an electrode system, the potential at any point is lower than that due to the electrodes themselves in the absence of current owing to the surrounding space-charge. In practice, this depression of potential has three important effects: (*a*) the potential may drop to zero at some point, forming a virtual cathode, some electrons being brought to rest there and returning to the nearest positive electrode; (*b*) a beam which would be homogeneous in velocity is rendered inhomogeneous because the potential is depressed by different amounts in different parts of the beam; (*c*) electric fields may be introduced altering the electron paths; for example, an otherwise parallel beam is caused to diverge by its own space-charge. It is important for design purposes to be able to calculate the magnitudes of these effects due to a given current in a given electrode system, but this is possible only in a few cases of simple geometry. Examples are given to indicate the usefulness of such calculations. The possibility of bringing all the indicated results within the scope of a single paper is simplified by the universal appearance in the analyses of a certain fundamental dimensionless parameter which is defined in terms of a current density, a length, a potential, and the ratio of charge to mass of an electron. For completeness, the case of the space-charge limited diode has been included, this being the simplest system the action of which is governed by space charge.

Profiles of Hydrogen Lines in Two Class B Stars

A. Vibert Douglas and D. C. West have compared the theoretical line widths computed by Verweij with profiles of certain Balmer lines in spectra of γ Pegasi and ι Herculis (*Mon. Not. Roy. Astro. Soc.*, 102, 1; 1942). The observational data display marked contradictions, and these show how great are the uncertainties introduced by the method of calibration of a spectrum and the construction of the intensity profile from the microphotometer trace. The material forming the basis of the paper comprises seven 3-prism spectrograms of γ Pegasi and one 1-prism and four 3-prism spectrograms of ι Herculis. From these, microphotometer traces were made and intensity profiles were constructed from the wedge calibration on each plate by means of the reduction data of C. S. Beals (*Pub. Dom. Astrophys. Observ.*, Victoria, B.C. (vi), 9, 98–101; 1934). The actual profiles and also the theoretical profiles of Verweij are plotted and many interesting comparisons are made, very marked discrepancies occurring in some cases. Comparison is also made regarding total absorption in five Balmer lines, and the temperature corresponding to the values of total absorption for $H\beta$, $H\gamma$, $H\delta$ is from 19,000° to 21,000°, though it should be pointed out that these figures were obtained by "making a risky extrapolation". The percentage absorption at line centre is shown in a table and compared with the values obtained by C. T. Elvey and E. G. Williams. An editorial note points out that the hydrogen profiles predicted by Verweij's theory, with which the observations of the paper are compared, are based on Pannekoek's calculated values of the continuous absorption coefficient *k* (*Pub. Ast. Inst. Amsterdam*, No. 4; 1935). Pannekoek has revised these values since, the revised figures appearing in an addendum to the paper referred to.

FORESTS OF NEW ZEALAND

IN the opening pages of the annual report of the New Zealand State Forest Service for the year ending March 31, 1941, by Mr. Alex. R. Entrican, director of forestry (Govt. Printer, Wellington; 1941), presented to both Houses of the General Assembly, a résumé is given of a broad-based and wide-visioned forest policy. The aims laid down are the more significant in that they are expressed with a full knowledge of the calls which the War is making on the forests and the forest service of the Dominion.

On the subject of forest policy, which demands the widest foresight in modern warfare, it is stated that the State Forest Service is rapidly attaining a full war-time footing. As never before, war has reduced all forest issues to one simple problem, that of meeting an increasing and ever-changing demand for timber. Month by month this has claimed more and more of officers' time until in some instances their peace-time activities have been reduced to vanishing point. To conserve man-power, continuation of this trend is inevitable, and the Department's programme of work is being re-oriented accordingly. Fire protection, timber appraisal and utilization activities with their direct contribution to essential war-time production have been intensified, but with two exceptions all other activities either have been or are in course of being reduced to a mere skeleton basis. The two exceptions are staff training and planning, upon which the whole resources of the Department surplus to the war effort must be concentrated.

Prior to the appointment last year of additional technically trained personnel and their assignment to sylvicultural and forest-management duties, it was realized that more particularly in the State exotic forests some losses must be anticipated due to haphazard planning and lack of trained staff over a long period of years. Even prior to the great depression, organization and personnel were entirely inadequate to the Department's rapidly increasing responsibilities, and both the depression and post-depression periods have served to accentuate the disparity between volume of essential work and available trained staff. The seriousness of the position can no longer be ignored, and any attempt to correct it merely by intensification of current training methods must fall far short of minimum requirements. Although military service precludes the training of an adequate junior staff at present, such temporary arrangements as have proved possible have been made, including the establishment of a forest ranger school. It is hoped that at the end of hostilities a number of scholarships in overseas universities will enable forest officers now on military service to qualify for professional duties.

Perhaps the three major forestry preoccupations of the present time are connected with the indigenous forests, the artificially formed exotic forests and erosion. The general forest inventory carried out during 1921–25 demonstrated the necessity for establishing a capital forest resource of exotic softwoods to supplement declining supplies of native timbers until such time as the indigenous forests, which in the past had had to bear the lumbering operations connected with the opening out of lands for farming purposes accompanied by wasteful fellings and fires, could be brought into full productivity. The vital present necessity is the organization of immediate future supplies for the industry not s much for the war period as for its aftermath, whe demand, it is expected, will expand on a considerabl scale. A five-year programme of forest developmen for both Kauri and white pine has been prepare and a survey of standing rimu supplies is in progres It is suggested in connexion with the indigenou forests that consideration will have to be given t the control of fellings on privately owned fores land with the view of conserving supplies and keepin the land reasonably productive, not ignoring th cogent objective of maintaining an effective vegetative cover in the interests of counter-erosion.

On the subject of the private and State exoti forests the report is illuminating. A grave warnin on their poor condition was given in the previou year's report. While interim experience has serve to confirm the worst fears in respect of faults c establishment due to the excessive annual area afforested on inadequate knowledge of localit factors, etc.—wide espacement, choice of wron species and sites, general location, etc.—the indications are that no less trouble is likely to arise throug long-continued neglect of sylvicultural operations Both threaten the health and vigour of many stands some of which may be affected to such an extent a to become potential focal points for widesprea insect and fungal attacks of an epidemic character and others in such a manner as to preclude bot cheap logging and cheap and quick re-establishmen by natural regeneration, thus necessitating slower more costly and less effective re-establishment b planting. As the Director correctly states, thoug the financial authorities in many parts of the Britis Empire have proved hard to convince, "in th ultimate analysis, sylvicultural treatment is no les essential to the continued functioning of the forest than the regular supply of oil and grease to hydro-electric turbines". But this is impossible unles provision is made in the forest budget irrespectiv of whether the operations concerned will be remunerative or otherwise.

The question of soil erosion has been a subject c considerable public discussion; and it is admitted t constitute a serious threat to the success both of th general forest policy and to the future developmen of the saw-milling and allied forest industries. Arden conservationists of the extreme type go so far as t claim that the more inaccessible forests still existin should be reserved from milling operations. "Th Forest Service", says the Director, "continues t advocate a realistic approach to the problem of soi erosion through Dominion-wide control of land burning operations. No other measure can giv such effective results either as quickly or as economically. A conservative estimate of its effectiveness i placed at 80 per cent of the theoretical maximum So aggressive is the New Zealand vegetation that n ground is too barren to resist its invasion—that i if burning is controlled. Too often observation c erosion is limited to pastured slopes heavily scarre or even deeply gullied without realizing that ever forest-clad hillside bears scars and gullies, thoug many are so healed by the ever-invading vegetatio as to defy casual detection. But whereas repeate and uncontrolled burning aggravates and perpetuate the one, controlled use of fire arrests and heals th other. Even much of the harmful effect attributabl to overgrazing is a direct result of indiscriminat burning, and would therefore be corrected by contro of firing operations. Simple as the premise is, i provides the most practicable and economic method of preventing accelerated erosion".

There are many parts of the British Empire where erosion in one form or another is becoming an ever-increasing danger to the means of livelihood of the populations, as is the case, for example, in large parts of Africa. The above remarks of the Director on a suggested method of control may be commended to the administrations concerned; in fact, the whole report—a war-time report—would repay a careful study by all having administrative responsibilities in connexion with the land and its well-being throughout the Empire.

MODERN DEVICES CONTROLLING ELECTRICAL CIRCUITS

A PROGRESS review on "Circuit-controlling Devices on Power Supply Systems" has been given by C. W. Marshall (*J. Inst. Elect. Eng.*, 89, Pt. 1; April, 1942). The review commences with a summary of the technical aspects of power circuit control, considered in three main sections: limitation of current amplitude, limitation of voltage, and making and breaking of circuits.

The paper then proceeds to illustrate what has actually been accomplished by reference to outstanding features of switchgear construction. Illustrated examples are given of a 0·4-kv., 600-amp. air circuit-breaker, a 0·4-kv., three-phase, 800-amp. rating, switchboard, an 11-kv., 750 Mva. metal-clad circuit-breaker, a five-panel assembly of 11-kv., 500 Mva., metal-clad switchgear with circuit-breakers of the draw-down type; the latter are fitted with arc-control devices. A pictorial sectional view of a modern switching unit is given, and shows *inter alia* the circuit-breaker, the means of connecting it to the busbars and to the outgoing circuit, and also the disposition of the current and voltage transformers.

A 33-kv. metal-clad switchgear is depicted, the busbar chambers in this case being filled with 'Freon' gas, and fitted with removable circuit-breakers. A third type of 33-kv. metal-clad switchgear is shown in which small oil-content type circuit-breakers are arranged horizontally. Two other small oil-content breakers are illustrated, one being an electrically operated type with a horizontal breaker, while the other has a vertically mounted breaker operated by compressed air. The last example of 33-kv. practice shows one of the most advanced and interesting designs which is available for commercial application. The general busbar structure follows standard metal-clad practice. The circuit-breaker, however, is of the air-blast type and this development is believed to be unique.

Two examples of 66-kv. switchgear are shown, the first being of the vertical type with double busbars and oil-immersed busbar selectors, while the second is a single-break, small-oil-volume, porcelain-clad unit. A group of 132-kv. units is shown, including a large-oil-volume circuit-breaker originally fitted with four open breaks and converted to a double-break type with arc control. Another illustrates the transition from the large-oil-volume circuit-breaker with steel tanks to the small-oil-volume, porcelain-clad type. A cross-sectional view illustrates all the essential parts of one phase of the breaker, and a photograph shows the complete assembly of a three-phase unit and offers a good idea of its size.

The practical performance of the various classes of installation is assessed, short-circuit test performance figures are given for typical circuit-breakers, mention is made of the test performance of modern fuses, and a tribute is paid to the remarkable efficiency of the various short-circuit testing stations. The period reviewed has been remarkable for the advance in knowledge of the intimate phenomena of arc rupture due to the fundamental research work of the British Electrical and Allied Industries Research Association, supplemented by the development work done in the various British switchgear testing stations.

A.R.P. AND THE ENGINEERING INDUSTRY

A CONFERENCE on air-raid precautions and the engineering industry arranged by the Institutions of Electrical, Civil and Mechanical Engineers with the co-operation of the Ministry of Home Security (Research and Experiments Department) was held at the Central Hall, Westminster, on December 9, and summaries of the three addresses delivered are contained in the *Journal of the Institution of Electrical Engineers* (89, Pt. I, April, 1942).

In an address on the "Effect of High Explosives on Structures", Prof. J. D. Bernal said that the main effects of explosions were covered by describing the arrival of the bomb or mine, and then the three chief mechanisms by which mines and bombs cause damage: blast; bomb fragments; earth shock when a bomb explodes in the ground. The distance a bomb travels before exploding is of more importance than the distance of penetration. This is determined not by the penetrating power but by the kind of fuse it carries. The distribution of fragments from a bomb exploding in air was explained to consist of three zones: those shot off at right angles to the side of the bomb, forming the main fragment zone; tail fragments, usually light; and nose fragments, usually heavy. The simple physics of the released gases was explained in connexion with peak blast pressure. An analysis was given of the reactions of a structure to blast, mention being made of the fact that resonance can be a contributory cause to damage if the half-period of the structure is of the same order as the time-interval between maximum pressure and maximum suction. The effects of shock waves from bombs exploding subterraneously were also described.

Prof. J. F. Baker dealt with the "Design of Protective Structures and the Defence of Industry" in an address which described principles of structural design for protecting industry from air attack which, though unfamiliar in normal engineering practice, can claim recognition as rational. Effective resistance was explained to be achieved by resistance accompanied by provision against failure by shear, while ductility in material and continuity in structural form combined with mass are essential if the structure takes the form of a wall. Recommendations were made for the protection of workers by shelters, and suggestions made as to a rationalized system of structural design for strengthening floors to carry loading by debris and for stability under earth shock. The criterion of proper protection was stated to be such that, having regard to war hazards, the total probable output over a period of all existing factories shall be thereby increased by a greater amount than if the work had gone into building new factories to be equipped with machine tools, the economic standard of protection depending ultimately on the scale of air attack.

A survey was made by J. W. Martin of the "Gas Contamination Problem in the Engineering Industry, with Special Reference to Electrical Machinery", and it dealt with the effects of gas contamination on the properties of materials and the functioning of machines, and with the consequent risk to workers operating the machines, or working near enough to be affected by vapour. Particular problems arise in connexion with the insulation of electrical machinery. An important factor in electrical work is the specific resistivity of liquid gases, owing to the danger of flashovers. It was concluded that the chances of contamination causing serious dislocation of industry are not high, and risks can be appreciably reduced by relatively simple means. Where contamination of plant occurs it need not mean the closing of works for long periods. It is advisable to replace the intricate and complicated instruments and components of plant that become contaminated. The emphasis should be on putting the plant into operation, contaminated work in progress being dealt with as a salvage operation.

FORTHCOMING EVENTS

(Meeting marked with an asterisk is open to the public)

Tuesday, June 16

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. Alf. Sommerfelt: "The Social Origin of Linguistic Categories".

Wednesday, June 17

Institute of Chemistry (London and South Eastern Counties Section) (in the Chemistry Lecture Theatre, West Ham Municipal College, Romford Road, London, E.15), at 6 p.m.—Dr. H. Baines: "Recent Advances in Photographic Theory".

Thursday, June 18

Chadwick Public Lecture (at the Chelsea Physic Garden, Swan Walk, London, S.W.3), at 4 p.m.—Mr. E. Augustus Bowles: "Plants in relation to Food, Medicine or Poison".*

Chemical Society, Institute of Chemistry and Society of Chemical Industry (Bristol and South-Western Counties Sections) (in the University Chemical Department, Woodland Road, Bristol), at 6.30 p.m.—Mr. J. Lumsden: "Statistical Methods Applied to Chemical Problems".

Saturday, June 20

Institute of Physics (London and Home Counties Branch) (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 2.30 p.m.—Conference on "The Eye in Industry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (Woman) for Geography and Mathematics in the Crewe County Training College—The Director of Education, County Education Offices, City Road, Chester (June 18).

Lac Information Officer—The Central Register (Reference O.N.F. 547), Ministry of Labour and National Service, Sardinia Street, London, W.C.2 (June 20).

Chief Lecturer in Mechanical Engineering—The Principal, Walsall Technical College, Bradford Place, Walsall (June 20.)

Assistant Dairy Bacteriologist—The Registrar, The University, Leeds 2 (June 25).

Lecturer in High Voltage Engineering and an Assistant Lecturer in Electrical Engineering—The Registrar, College of Technology, Manchester 1 (June 30).

Lecturer in Science—The Principal, Domestic Science Training College, Knighton Fields, Leicester.

Lecturer in Biology—The Principal, Bishop Otter College, Chichester.

Two Analysts—The Director of Research, Research Association of British Flour-Millers, Old London Road, St. Albans, Herts.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Geological Survey of Great Britain: England and Wales. Wa time Pamphlet No. 4: Water Supply from Underground Sources the Oxford–Northampton District. Part 1: General Discussion. B Dr. A. W. Woodland; with a Contribution on Rainfall, supplied b the Director, Meteorological Office, Air Ministry. Second edition. P 35. (London: Geological Survey and Museum.) 1*s.* 8*d.* [3

Reconstruction. Report by the Federation of British Industrie Pp. 31. (London: Federation of British Industries.) [3

British Rubber Producers' Research Association. Publication N 16: Rubber, Polyisoprenes and Allied Compounds, 1: The Synthes of Low-Molecular Polyisoprenes of the Rubber and the Squalene Typ By E. H. Farmer and D. A. Sutton. Pp. 6. Publication No. 17: Th Course of Autoxidation Reactions in Polyisoprenes and Allied Com pounds, 1: The Structure and Reactive Tendencies of the Peroxid of Simple Olefins. By E. H. Farmer and Alvappillai Sundralingan Pp. 19. Publication No. 18: The Course of Autoxidation Reaction in Polyisoprenes and Allied Compounds, 2: Hydroperoxidic Structu and Chain Scission in Low-Molecular Polyisoprenes, by E. H. Farm and D. A. Sutton; The Autoxidisability of the Alkyl Groups i Xylene, by E. H. Farmer and E. S. Narracott. Pp. 11. Publicatio No. 19: The Efficiency of Pneumatic Tyred Tractors under Far Conditions. By E. W. Russell, H. J. Hine and B. A. Keen. Pp. 42+ plate. Publication No. 20: The Interaction between Rubber an Liquids, 1: A Thermodynamical Study of the System Rubber–Benzene. By G. Gee and L. R. G. Treloar. Pp. 19. Publication No. 21 The Caoutchol Component of Natural Rubber; a Correction. B K. C. Roberts. Pp. 3. (London: British Rubber Producers' Researc Association.) [4

Other Countries

Smithsonian Miscellaneous Collections. Vol. 101, No. 12: Th Quantity of Vaporous Water in the Atmosphere. By C. G. Abbo (Publication 3678.). Pp. ii+7. Vol. 101, No. 13: A New Titanother from the Eocene of Mississippi, with Notes on the Correlation betwee the Marine Eocene of the Gulf Coastal Plain and Continental Eocen of the Rocky Mountain Region. By C. Lewis Gazin and J. Magrude Sullivan. (Publication 3679.) Pp. ii+13+3 plates. (Washington D.C.: Smithsonian Institution.) [26

The Engineering Foundation. Annual Report, October 1, 1940, t September 30, 1941. Pp. 47. (New York: The Engineering Foundation.) [26

U.S. Department of Agriculture. Technical Bulletin No. 798 Relationship of Insects to the Spread of Azalea Flower Spot. B Floyd S. Smith and Freeman Weiss. Pp. 44. (Washington, D.C. Government Printing Office.) 10 cents. [26

Forest Bulletin No. 103: Jute Cuttings for Paper Pulp. By M.P Bhargava and A. N. Nayer. Pp. iii+5. 3 annas; 4*d.* Fores Bulletin No. 104: Studies on Coal Tar Creosote as a Wood Preservative, Part 1: Creosote Extracted from Timbers in Service. By D Narayanamurti and V. Ranganathan. Pp. iv+18. 12 annas; 1*s* (Delhi: Manager of Publications.) [26

U.S. Department of Agriculture. Circular No. 616: Methods o Breeding *Chelonus annulipes* on the Mediterranean Flour Moth fo use against the European Corn Borer. By William G. Bradley. Pp. 23 (Washington, D.C.: Government Printing Office.) 10 cents. [28

U.S. Department of Agriculture. Farmers' Bulletin No. 1895 Land Slugs and Snails and their Control. By W. H. White and A. C Davis. Pp. ii+8. 5 cents. Technical Bulletin No. 793: Evaluation o Baits and Bait Ingredients used in Grasshopper Control. By Robert L Shotwell. Pp. 51. 15 cents. Technical Bulletin No. 797: Boro Distribution in Soils and related Data. By Richard R. Whetstone William O. Robinson and Horace G. Byers. Pp. 32. 10 cents. (Washington, D.C.: Government Printing Office.) [295

Imperial Council of Agricultural Research. Miscellaneous Bulleti No. 44: The Manufacture of Insulation and Pressed Boards, Wrapping-Papers and Straw-Boards from Bagasse. By M. P. Bhargava and A. N. Nayer. Pp. iii+21+6 plates. (Delhi: Manager of Publications.) 1.4 rupees; 2*s.* [16

U.S. Department of the Interior: Geological Survey. Bulletin 883–C: Spirit Leveling in Texas, Part 3: West-Central Texas, 1896–1938. Pp. ii+151–239+1 plate. 15 cents. Bulletin 883–E: Spirit Leveling in Texas, Part 5: South-Central Texas, 1896–1938. Pp. ii+561–789+1 plate. 30 cents. Bulletin 931–D: Nickel-Gold Deposit near Mount Vernon, Skagit County, Washington. By S. W. Hobbs and W. T. Pecora. (Strategic Minerals Investigations, 1941.) Pp. iii+57–78+plates 11–12. 15 cents. (Washington, D.C.: Government Printing Office.) [16

U.S. Department of the Interior: Geological Survey. Professional Paper 196–B: Geology and Biology of North Atlantic Deep-Sea Cores between Newfoundland and Ireland, Part 3: Diatomaceae. By K. E. Lohman. Pp. xx+53–86+9 plates. 45 cents. Professional Paper 196–C: Geology and Biology of North Atlantic Deep-Sea Cores between Newfoundland and Ireland, Part 4: Ostracoda. By Willis L. Tressler. Pp. xviii+95–104+4 plates. 15 cents. (Washington, D.C.: Government Printing Office.) [16

U.S. Office of Education: Federal Security Agency. Annual Report of the United States Commissioner of Education for the Fiscal Year ended June 30, 1941. Pp. vi+120. (Washington, D.C.: Government Printing Office.) [16

Proceedings of the American Academy of Arts and Sciences. Vol. 74, No. 12: Freezing Parameters and Compressions of Twenty-one Substances to 50,000 kg/cm². By P. W. Bridgman. Pp. 399–424. 60 cents. Vol. 74, No. 13: Pressure-Volume Relations for Seventeen Elements to 100,000 kg/cm². By P. W. Bridgman. Pp. 425–440. 85 cents. (Boston, Mass.: American Academy of Arts and Sciences.) [36

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PHYSICS
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THE FUNCTION OF BRITISH RESTAURANTS

BRITISH Restaurants may be said to have started as an improvisation and to continue as a compromise; how they will develop in the near and distant future is uncertain. Their original object was to supply a solid meal to those who, owing to bombing, could not get their meals in their customary way; but other objects have been grafted on. First, they serve the same purpose as works canteens, they supply meals to workers in factories that are not covered by the Factory Canteens Order, and to others who work far from home. Then there is the economy motive; they reduce waste of foodstuffs; less labour is needed for preparing and cooking food when a hundred or more are fed in a restaurant than when they eat in groups of three and four at home. Women are better able to go to work in factories if they are relieved of the task of preparing the main meal of the day. Finally, there is the motive that has been behind the expansion of the school meals service—improvement of the standard of nutrition; the British Restaurants insure that anyone can get a nutritious meal at a low price.

As the knowledge that meals in British Restaurants are good and cheap has spread, more and more people have gone to them; so that now, besides factory and clerical workers and shop assistants, professional men and women, students, bishops and tramps now eat together in a friendly and sociable atmosphere. All of which is excellent; but the time has come to think about the consequences and the whole purpose of these communal meals. As it is, they encroach on the business of private caterers; they threaten to disturb the business of food retailers; and if they come to serve a large proportion of the population they will upset the system of rationing, particularly of meat. In January of this year Lord Woolton assured a deputation from various caterers' associations that if a local authority wished to open a British Restaurant and the local caterers think it unnecessary, an official will be sent to investigate before approval is given by the Ministry. This may mean much or little; all depends on the criteria on which the Ministry's decision is based. Some day it will be necessary to decide who it is that the British Restaurants are intended to serve, and what purpose they are intended to play in our system of food control. It may be assumed that they are intended to provide for those workers who cannot go home for their midday meal. It might seem desirable to carry the system to its extreme and to supply the whole population with a solid meal in a British Restaurant. As we shall see later, it is doubtful how far this could be justified, even on the grounds of economy; but in any event expansion is limited by other factors.

The present British Restaurants, particularly the older ones in London, must be improved if they are to continue to supply satisfactory meals under favourable conditions. The shortage of equipment is being overcome; small tables with green linoleum tops are taking the place of trestle tables, and chairs are supplied in place of benches. The newer restaurants are so arranged that customers pass a series of hatches from which they can take their food; but in the older restaurants they wander from one serving table to another. The worst trouble is overcrowding; customers who come, and must come, at the rush times have to wait in long queues; in the dining-rooms there is no space between the backs of the diners' adjoining tables. Partly because of the time wasted in the queue, partly from a feeling that they must finish and make room for others, diners hurry over their meals. This overcrowding results, in the main, from the need to improvise restaurants in any buildings available, however unsuitable or small. One may contrast the British Restaurant in Dunmow, in which the kitchen is on an upper floor, and the dining-room (the sorting room of the old Post Office, with a glass roof) is bright and airy, with one near Red Lion Square, London, in which the food is cooked and eaten in the same overcrowded room. No other building can be found in the neighbourhood; most that might have served have been destroyed by bombing. As no extensive building is allowed at present it will be difficult to relieve this overcrowding unless some private premises are commandeered. Even with more and better buildings it may not be possible to staff them. As more women are drawn into the Services or into industry it becomes more and more difficult to find both paid cooks and voluntary helpers. It is, therefore, hard enough to cope with the present number of diners; and, as the demand increases, it will be necessary to select the patrons in some way if no further provision is made for the meals service.

Agreeing that one of the purposes of the British Restaurants is to raise the level of nutrition, how far can they be used as media for education in the better use of food, and how far can they be improved? At present most of the meals consist of the traditional meat and two vegetables, followed by pudding. It is suggested, for example, that meals of the Oslo type might be introduced. However, this education needs a personal approach. If the diners are merely supplied with strange food they may eat it, but they will not come again. The personal approach is possible in schools and in some factory canteens; but it is out of the question when diners enter in a queue of a hundred or more, and eat hurriedly in a crowded room; certainly none of the staff has time for discussion during meal times. A nucleus of diners ready to set an example by eating different food may influence the rest; but with a small staff and large numbers to serve, it is not possible to prepare the special dishes needed.

Critics of the meals provided should realize that there is much sound physiology behind the traditional dinners. The meals have been stigmatized as 'too starchy'. But starch is the main source of energy of the people of the world. A few only of the more favoured; whose energy expenditure was not large, may have been able to get a fair proportion of their daily calories from protein and fat; but in the present days of shortage this is not possible. The rations even to canteens for heavy workers, allow only some 200 mega-calories per meal from meat, cheese and butter. If the meals supply, as is intended, about one third of the day's energy requirement, the greater part must be derived from starchy foods. Actually Miss Abrahams reported to the Nutrition Society's Conference on May 30 (see p. 685 of this issue) that only a few of the meals that she measured supplied 1,000 mega-calories—one third of the 3,000 mega-calories that are commonly accepted as an average day's requirements. It would be better if the starchy food, bread, were supplied free in all restaurants, in order to ensure that sufficient energy should be furnished by the dinner. Also critics should be sure that their criticisms are sound. Most manageresses have been told that a large proportion of vitamin C dissolves out of potatoes if they are peeled and left in water overnight; that they should, therefore, be peeled in the morning before cooking. Anyone who has had practical experience of the difficulty of the extraction of ascorbic acid from raw potatoes, even when they are ground up, would suspect the first statement; actually experiments have shown that it is untrue. No methods by which the staff could peel some hundredweights of potatoes in the morning in time to be cooked were ever suggested. Because of the practical difficulties involved in its application this particular piece of advice has been remembered when better things have been forgotten, and most manageresses are left with the belief, however politely concealed, that dietitians are armchair faddists. Similarly, it is not possible, with limited equipment and with limited time, to put green vegetables into the boiling water in small instalments. However, as the experiences related at the Conference showed, the preparation of vegetables in some kitchens is unsatisfactory, and improvements, with the object of conserving vitamin C, are possible.

Two methods whereby the meals might be improved may be suggested. First, arrangements might be made for visits by manageresses to restaurants in other districts, so that they might exchange experiences. A conference of restaurant staffs might help; it is a matter for regret that only one speaker at the Conference of the Nutrition Society put the view of a manageress. Second, an experimental team might visit those restaurants in which there is room and demonstrate new methods of using food; this would certainly be possible with the Oslo type of meal. In the meantime, studies on the nutritional value of the meals, as served, should continue.

There are two possible changes that do not directly concern the staff of the restaurant. First, the working-class adolescent is, as usual, forgotten. He or she needs extra protein just as much as a school-child. True, he *may* get 1½ pints more milk per week than an adult, but this supplies only 4 gm. of protein per day; and, as an adolescent is not (and if female, never will be) regarded as a 'working man'; he (and still more she) is not likely to get his or her full share of the family meat ration. There is a good case for doubling the meat allowance for all who are under the age of eighteen, as shown by their identity cards. Also it should be possible to make a reduction in cost for the under-eighteens; otherwise the meals will take up too large a fraction of what is left of their wages, after unavoidable expenses are met. Actually, in many restaurants the proportion of the diners who are under eighteen is very small, possibly because they find the cost too high.

Another change that should improve the quality of the meals is an alteration in the system of buying. The principle has been to use the normal channels of trade. Most British Restaurants get their supplies of meat, fish, dairy products and vegetables from local retailers at full retail prices, or less a small discount only. The system of central buying should reduce the cost and, particularly with regard to vegetables, improve the supply. The risk of deficiency of vitamin C during the early months of the year, now that imported fruit is almost unobtainable, was discussed at the Conference. Attention was focused on the conservation of the vitamin C of vegetables, either by better cooking or by no cooking at all. No mention was made of another aspect of the food situation; vitamin A from animal sources (milk, butter, margarine, cheese and eggs) is limited by rationing by an average of some 1,000 international units per day; the rest of the requirements must be made up from the carotene of roots and, particularly, of green vegetables. The supply of carotene falls off in March, just as much as that of vitamin C. True, stores of vitamin A can be accumulated in the body when the intake is high, but there is little likelihood of a liberal supply of vitamin A at any time of the year. The situation with regard to vitamin A would not be affected by changes in methods of cooking; but an ample supply of green vegetables would satisfy requirements of both vitamin C and vitamin A.

At present the vegetables grown on a large scale are mainly those that travel well, for example, cauliflowers and the compact type of cabbage with a white heart; both of these contain relatively little carotene. Winter hardy greens, such as curly kale, and sprouting broccoli, that comes early in spring, are neglected. There is a contrast between country schools that grow their own vegetables, and country British Restaurants that buy from a shop; and between British Restaurants in town and those in the country, since the best supplies go straight to town. One British Restaurant in a small town had a difficulty in getting green vegetables during the second week in May of this year. The difficulties of provincial British Restaurants could be overcome if local authorities grew their own vegetables or contracted directly with local growers, and arranged what should be grown. Some such local organization would do much to prevent the waste and expense of the distribution of vegetables that were exposed in the debate in the House of Lords on June 3. But if the experience of this year, when for three weeks in March little green stuff except brussels sprouts at 10*d*. or more per lb. could be bought, is to be avoided next year, something must be done at once.

Another improvement which a central organization of the food supply would make possible is the introduction of central factory kitchens as described by Mr. Le Gros Clark at the Conference. This would relieve the staffs of restaurants of a considerable fraction of the work of preparing food and allow a greater variety of dishes at any restaurant.

If British Restaurants are continued after the War ends, they may cater for a small proportion of the population, as at present, or they may be extended until they replace the family system. It cannot be assumed that such an extension is justified on grounds of economy alone. At first sight it seems obvious that fuel is saved and labour better used if many small cooking units are replaced by one large unit. But actually domestic economy is an integrated whole. If one part is taken away the system works less economically. The kitchen fire not only cooks the dinner but also heats the house, besides water and other meals. If it is not used to cook dinner its use for other purposes becomes wasteful. In the same way the housewife spends her time in many other household jobs besides cooking dinner, and she may have to look after children. If the labour of a mother with young children is used outside her home, someone else must at least look after her children while she is away. This means crèches or nursery schools, premises to accommodate them and qualified women to look after the children. Even then there remain jobs to be done before and after working-hours—washing children and attending to clothes, cleaning the house, and getting other meals. If a woman does this as well as an ordinary day's work, it is not an economy of labour, but sweated labour. A general system of communal meals, with employment of married women outside their homes, can be justified on grounds of economy of labour only as part of a complete system of communal life, with homes reduced to dormitories rather than living places.

In the U.S.S.R. communal meals have been encouraged for much the same reasons as have led to the introduction of British Restaurants; there was also the factor that they fitted the Bolshevik outlook; they, together with the type of housing adopted, were part of a communal system. However, Le Gros Clark and Brinton in 1935 found a tendency to revert to eating at home. It would be interesting to know how the matter stood in 1939. Communal restaurants were started in Germany and Austria in the large towns during the War of 1914–18, and remained open after the War. In Vienna they were still running up to the time of the *Anschluss.* They were mainly found in the central part of the city and fed a larger number than do the British Restaurants in the central parts of London. They catered mainly for the working population of the city centre (which included few factory workers) and people who preferred to eat away from home. A good three-course meal with a choice of dishes cost one schilling (equivalent to about 10*d*.); a large *eintopf* dish was still cheaper. It was not possible to prepare similar meals so cheaply at home.

This is the type of service that the British Restaurants will, in all probability, offer after the War. As building becomes possible better premises should be provided and various meals at different prices be introduced. We may hope that in the end the

Restaurants will not only insure a good level of nutrition by supplying good meals at low prices, but will also provide amusement and entertainment, much as in J. B. Priestley's vision of "Smoketown". Whether they come to form part of a complete system of communal life it remains for the future to decide*.

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* For a general account of British Restaurants, Works and School Canteens see "Community Feeding in Wartime" by Barbara Drake (Fabian Society) and, for organization, a pamphlet with the same title published by H.M. Stationery Office.

LIFE AND LABOUR

Fighting for What?

By Sir John Orr. Pp. xiv+90. (London: Macmillan and Co., Ltd., 1942.) 2*s*. 6*d*. net.

"A THIRD of the population in the United Kingdom and about an equal proportion in the United States do not enjoy food and shelter on the standard needed for health. In most other countries, the proportion of the population which has never been adequately fed or adequately housed is even higher. Among the native races, for whose welfare Britain is responsible, only a relatively small proportion of the population have houses in which they can live in decency and food on the health standard."

These are Sir John Orr's words; and they are an indictment by science against society preferred to a world jury at a critical epoch in the history of civilization. As the result of many investigations carried out in recent years at a number of scientific institutions, the minimum and optimum nutritional needs of human beings have been determined, and general agreement has been reached as to dietary standards necessary to maintain health and growth. When the constituents of a diet are wrongly balanced, as measured by these standards, or when the supply of foodstuffs is inadequate, there is an increase in the incidence of deficiency diseases and a weakening of resistance to others, as well as stunted growth and general physical disability. Over-feeding, like other forms of intemperance, brings its own penalties upon the body and mind, and is a type of malnutrition due to self-indulgence rather than to lack of knowledge of dietary requirements.

Dietary habits can be improved by increasing the interest of public health authorities in the modern science of human nutrition and its everyday applications. No educational agencies of this kind can, however, be of much value unless the foodstuffs required for dietary standards are within the reach of all who need them. To advise people what they should eat to maintain health and strength, and not to ensure that they can obtain the food they require, is to make a mockery of knowledge. It is comparable to the naïve suggestion related in French history that if a starving people could not obtain bread they should eat cake. The position to-day is that there is close agreement between scientific investigators and official bodies as to standard food requirements of human beings. It has also been established that, with the approach of diets to this standard, health and physical fitness are improved and the further the diets fall below the standard the worse these bodily conditions become.

An apocryphal story relates that after Galileo had shown to Pope Urban VIII that the earth revolved around the sun and not the sun around the earth, the Pope replied: "That is all very well, Galileo, but what are you going to do about it?" Similarly, as science has shown clearly what are the primary nutritional needs of man and also enabled them to be supplied in increasing abundance from the earth's store, social justice demands that something should be done to ensure that no member of the community is deprived of the means of healthy living. It may be trite to deplore the prevalence of poverty in the midst of plenty, but dietary poverty is preventable and ought, therefore, to be prevented, if only to save the social arteries from sclerosis.

In order to bring the diet of the whole population up to the health-level defined by the accepted standards of nutrition, additional amounts of protective and other foods would have to be made available for consumption. Whatever is required to reach this standard can be produced, and there cannot be over-production of foodstuffs so long as any human beings are hungry for them. It is possible to estimate with reasonable accuracy the food requirements of any community and to produce whatever is needed for the healthy nourishment of all members of it. To ensure these conditions demands, however, the institution of a food policy based on human needs and not dependent upon the profit-making interests of producers or distributors. Until these needs are satisfied, the problem of over-production cannot arise, and the wanton destruction of foodstuffs will be condemned as a crime against the community.

When the principle is conceded that the whole population should be able to obtain sufficient food to reach at least the minimum dietary standard, various difficulties arise in applying it. In pre-war days Great Britain imported about two thirds of the food she consumed. Both home production and imports would have to be increased in order to supply the necessary food on a free-choice basis. Sir John Orr contemplates a great expansion of agriculture at home and abroad to provide such supplies and suggests what foods should be produced in Great Britain and what should be imported in order to raise the total supplies to the level of consumption required for a health basis. This means a re-orientation of British agricultural practice towards that of Denmark and Holland, to supply foods which can be produced at home as easily and cheaply as they can be produced abroad, and the importation of such foods as wheat, beef, mutton and sugar which cannot be produced as economically here as in some other countries. There must be a great expansion of agriculture at home in order to produce the additional amounts of food required for home consumption, and the increased imports of food and feeding-stuffs would require increased exports of industrial products to pay for them. Increased agricultural and industrial output means increased employment and the creation of new national wealth as well as stability in trade.

The foodstuffs necessary to bring all the members of a community up to the safety-line of health are known just as a farmer knows what he has to produce or purchase to feed or fatten his herds of cattle. We know also that the amounts required can be produced and ought to be made available to the whole population. The principles of Sir John Orr's food policy are based upon these scientific facts. Their recognition makes supply and demand matters of international concern instead of profit and loss accounts of small or big businesses. With agriculture based on the needs of the population and industry expanding with it, production and trade would tend to become stabilized and the booms and slumps of food markets would be avoided.

A food policy based on the needs of the community and not upon considerations of private profit by business people who control the food industry would eliminate many vested interests and meet, therefore, with much opposition. When, however, the social conscience is convinced that the principles and the aims are right, action is bound to be taken to carry them out. Sir John urges that we should not wait until after the War to produce plans to enable this to be done. He suggests that a Food Planning Commission should be established now, and outlines an organization which might be devised for Great Britain. A National Food Board should be appointed by the Government and the members of it should be financially independent of the food trade. The National Board would be responsible for bringing the national supplies of the main foodstuffs up to the level needed to supply sufficient for everybody and for arranging that sufficient would be available within the purchasing power of everybody. The Board would exercise its functions through a number of Commodity Boards the members of which could include representatives of producers, distributors, consumers, and taxpayers, as well as of people having no financial interests in the food trade. These Commodity Boards would take over the functions of the existing Agricultural Marketing Boards, but would differ from them in not having the power to regulate production and fix prices in their own interests.

When the aim is to enable the whole community to obtain the food required to live, no sectional interests or actions should be tolerated which will prevent its attainment. The new policy involves certain changes in the food trades, but there is no reason why these should deprive producers and distributors from exercising initiative and free business enterprise for services supplementary to those of the Commodity Boards. Scientific inquiries have shown what a dietary standard for human beings signifies, both as to needs and increase of production necessary to satisfy them. There will have to be new economic policies and new international relationships if the necessities of life on a health standard are to be brought within the reach of all mankind. These elements of a new world constitution must be organized by financiers and traders not for their benefit alone but also as worthy service to the community.

Each country has its own problems of this kind to solve in order to bring an adequate diet within the purchasing power of the people in it, and in a world food policy every nation has a similar human responsibility towards poorer nations. This is already recognized in the steps being taken to provide food for peoples who have been deprived of it by conditions of war, and in the preparation of plans for post-war production and supply. Modern contributions to the science of nutrition, and the inquiries into the social economics of rich as well as of poor countries, have shown that a food policy such as that long advocated by Sir John Orr and outlined in the present book should be adopted by the United Nations as the sound and sure foundation of world stability. There are still many people who regard such an outlook as Utopian and unattainable, but the signs of the times are against them. The principles of the Atlantic Charter represent relationships which might well become articles of social faith among all free peoples and inspire a crusade to promote their application.

Since these principles of the cause for which the United States and the United Kingdom are fighting were stated, there has been a tendency to believe that action based upon them would not come above the horizon until after the War, and possibly not then. The announcement made by Mr. Roosevelt and Mr. Churchill on June 10 should remove all doubt as to their joint intention to put into practice the policies expressed in their Charter. In order to promote the most effective use of the combined resources of the United States and the United Kingdom for the prosecution of the War, they have established a Combined Production and Resources Board and a Combined Food Board. The purpose of the Food Board is to co-ordinate and obtain a planned and expeditious utilization of the food resources of the United Nations. All questions of supply, production, distribution and disposal of foods in which the Governments of the United States and the United Kingdom have common concern will be referred to the Board for inquiry and report, and also those relating to agricultural materials from which foods are derived and equipment and non-food materials used in the production of such foods. Moreover, the Board is to work in collaboration with others of the United Nations towards the best utilization of their food resources, and with any interested nation or nations to formulate plans and recommendations for development, expansion, purchase or other effective use of their food resources. The functions of the Board thus follow much the same lines as those of the organization outlined by Sir John Orr. The establishment of the Board gives good reason to expect the realization of his hope that "the Government is prepared to base post-war food policy on human needs and to co-operate with all other Governments to apply such a policy on a world-wide scale".

The two other primary material necessities of life are adequate housing and the opportunity to work. When the provision of the additional food and decent homes for all members of the community is undertaken by public authorities, and every citizen, rich or poor, is made to serve for a period in a National Service Corps, the unemployment problem will approach solution, and for the first time in history man will attain economic freedom. This is the cause for which Sir John Orr and many other social reformers are combining scientific knowledge with prophetic vision. It appeals to men of all creeds in all lands and makes world fellowship possible on a basis of common social needs and faith in the capacity of Nature and the spirit of humanity to remove the fear of want from the lives of all the peoples of the world. It was said long ago that "the poor shall never cease out of the land; therefore I command thee, saying, Thou shalt open thine hand wide unto thy brother, to thy poor and to thy needy in thy land." The "land" of Deuteronomy now extends to the whole earth and "to the children of men" dwelling in all parts of it. Every human being has a right to a just share of the fullness thereof and the obligation to add to his inheritance. Though the poor may always be with us in families and in nations, they should not have to depend upon alms-giving for the primary necessities of life while Nature and man can produce these in full measure and in the spirit of mutual aid. Sir John Orr's book is a stimulating call to all men and women of goodwill to join in a crusade to achieve this end.

R. A. Gregory.

NEW ATOMS FOR OLD

Mass Spectra and Isotopes
By Dr. F. W. Aston. Second edition. Pp. xii+276+12 plates. (London: Edward Arnold and Co., 1942.) 22*s*. 6*d*. net.

THE atomic theory of Dalton, accepted after many misgivings by nineteenth-century chemists, is now essentially discarded; Prout's hypothesis, rejected by Stas as "nothing but an illusion, a mere speculation definitely contradicted by experience", has returned to favour. One of the main factors in this transformation has been the discovery that the majority of the elements exist in two or more forms, which are chemically identical even though their atomic masses differ. These diverse species of the same element are known as isotopes, and when the word isotopes is mentioned one immediately thinks of Aston.

Although this welcome volume is announced as the second edition of "Mass Spectra and Isotopes", it constitutes in reality the fourth edition of Dr. Aston's pioneer monograph on "Isotopes", first issued in 1922. The change in title made in 1933 did not, as might appear to the casual eye, indicate a broadening of the ground covered. On the contrary, as the author himself specifically pointed out in his preface, the large development of the subject led him then to narrow the scope of the book a little—"it is now concerned less with general theory and more with experimental results, especially with those obtained by mass-spectrum analysis". The present edition very wisely continues this policy of restriction.

No doubt there will be readers who will regret that the book does not contain any discussion of induced radioactivity and artificial isotopes, but if Dr. Aston was justified in allotting a "somewhat disproportionally large space" to inactive isotopes twenty years ago in the hope that the inadequacy of his account of radioactive isotopes might stimulate the production of a separate volume dealing with this field, then it is obvious that it would be an impossible task nowadays to compress even a summary of all the important recent work on synthetic isotopes into a volume describing the stable isotopes in detail. One task at a time is prudent procedure, and Dr. Aston is entitled to feel a considerable amount of satisfaction in the fact that, in one important sense at least, the task to which he has devoted himself almost uninterruptedly for thirty years—the complete tabulation of the stable natural isotopes—has at length been triumphantly concluded. To quote his own words: "All the elements have now been analysed, and my main concern in writing this book is to tell how this has been done".

The tale is a thrilling one, and it is admirably told. The volume is indeed, in a fashion, a detective story of the very first class; Hercule Poirot or Lord Peter Wimsey would envy the skilful way in which one minute clue after another has been first distinguished and then relentlessly followed up until every atom of information has been drained out of it which might lead (and in every case, has led) to the identification of each individual connected with the mystery. No element possessed of a double, or multiple, personality has succeeded in concealing its duplicity, or multiplicity. "*Elementary*, my dear Watson!" might well be the motto on the title-page.

The experimental work involved, bristling with fresh difficulties at each forward step, has been meticulously careful from the very start, and has now attained an almost incredible order of accuracy. A most valuable feature of this edition is the inclusion of an entirely new chapter recording the remarkable recent advances in design of mass spectrographs, particularly the double-focusing types. The increase in exactness obtained by the employment of these formidable instruments may be recognized, in a very simple manner, by a comparison of Aston's original packing fraction curve (p. 81) with Dempster's 1938 model (p. 108). The atomic masses of all the significant natural isotopes of every element and their relative abundance have now been established with such certainty as to warrant the astounding statement (p. 216) that were the vast accumulations of chemical data comprising the grand total of direct atomic weight determinations lost, the table of atomic weights could be reconstructed to-day, entirely from mass spectrum evidence, as complete and, with the possible single exception of the element copper, as accurate as the table we now have.

Especially interesting in this connexion is the history of hydrogen, since it was an infinitesimal disagreement between the chemical and mass-spectrograph atomic weight values for this element that first led Birge and Menzel in 1931 to point out that, to bring the results into accord, hydrogen must contain heavier isotopes. Here the amusing case of a false clue leading to a correct deduction, rare in detective novels but still rarer in scientific work (Prout's hypothesis is an apposite example), is beautifully exemplified. "Fortunately unaware that, as we now know, the error in *each* of the estimates concerned was greater than the *total* discrepancy he was seeking to explain, Urey started his famous painstaking search which resulted in the remarkable discovery of heavy hydrogen, and for which he received the well-merited award of the Nobel Prize in 1934."

The fact that there are still plenty of unsolved problems in the general theory of the subject is well illustrated in Chapter 13, which deals with "Isotope Statistics". A number of interesting rules are cited, but their basis is admittedly still obscure in most instances. For example, why should elements of odd atomic number never have more than two stable isotopes, while elements of even atomic number may have up to nine or ten (p. 204)? Why should elements of even atomic number predominate to a very marked extent not only in the earth's crust, but also in such extra-terrestrial matter as meteorites (p. 207)? And why should there be so little apparent rhyme or reason in the relative abundance of isotopes (p. 210)?

Dr. C. P. Snow has made an excellent revision of the two chapters on the isotope effect in molecular and atomic spectra, which he wrote for the previous edition. In the whole book, I have detected only one error, namely the statement (pp. 259–60) that Lewis and Macdonald's partial separation of the isotopes of lithium was founded upon "the difference in the free migration velocities of ions"; it depended, in fact, upon a difference in their electrode potentials. In return, however, I am prepared to admit that I have corrected quite a number of false impressions in my own mind through the perusal of the volume, and have acquired a veritable mass of new knowledge. I venture to advise all my chemical and physical colleagues to go and do likewise.

JAMES KENDALL.

ECONOMICS IN THE U.S.S.R.

Soviet Economy and the War

By Maurice Dobb. Pp. v+88. (London: George Routledge and Sons, Ltd., 1941.) 3*s*. net.

Dear Joe

Letters from Bill Smith to Joseph Stalin. By E. W. and M. M. Robson. Pp. 96. (London: Martin Secker and Warburg, Ltd., 1942.) 2*s*. 6*d*. net.

THE closer political collaboration between Great Britain and Soviet Russia which has now materialized is as essential to the establishment of order and freedom in Europe when victory has been won as it is to the victory of the United Nations. That collaboration can scarcely be fully effective unless it is based on a mutual understanding and respect, and there is still room for literature which is designed to remove misunderstandings and give something more than a superficial picture of life and thought in the two different societies. Far too much of the mass of literature on Russia in Great Britain is objective, if not undisguisedly biased in one direction or another or frankly propaganda. Mr. Maurice Dobb's "Soviet Economy and the War" is a modest effort at an objective account of the economic system of Soviet Russia with reference to Russia's part in the War, and he stresses the urgent need for a more just appraisal of Soviet economy to-day if the alliance is to bear fruit in a practical policy and lasting co-operation of the two peoples. Mistakes in our foreign policy towards the U.S.S.R. will assuredly be repeated in the absence of accurate and unprejudiced knowledge of the economic and military potential of our ally.

Mr. Dobb makes a definite contribution to that better understanding, and he should at least banish the complacent assumption that the U.S.S.R. can bear the full weight of German war economy. For waging a prolonged war of attrition, he concludes that the U.S.S.R. is weaker than Germany as regards the economic basis of her war effort, if she has to face alone the full onslaught of the German war machine, although in some respects the U.S.S.R. is immeasurably stronger than in the difficult days of the First Five-Year Plan a decade ago. Apart from this, Mr. Dobb gives a clue to the root cause of the very high degree of initiative, as well as of morale and of enthusiasm, which has been shown by the ordinary people in the Red Army or Air Force and as guerilla fighters, or in the factory or ordinary civilian life. The value of the training and organization, under Soviet economy, of the ordinary workers and salaried staffs in industry, to participate in the discussion and concrete criticism of policy before it is made has received striking demonstration.

E. W. and M. M. Robson's book is another attempt at the interpretation of the British order of society with the view of mutual understanding. Written from the British point of view, it is acutely but constructively critical of certain elements of weakness in the Soviet order, and administers a wholesome corrective to some of the fulsome adulation of Soviet ways and ideas which has recently been popular. Unfortunately, much of the book is far from easy reading, and neither the exposition of the ideas or traditions of Anglo-Saxon democracy nor the analysis of those developments in Russia, belonging to the negative side of the revolution, which led to the signature of the pact with Hitler, are by any means so lucid as could be desired. None the less, the glimpse of the possibilities of Anglo-Soviet co-operation, and of renewal of the creative forces in both countries through the positive elements which have inspired such magnificent resistance to aggression, warrants the hope of a further attempt on similar lines with a wider and more popular appeal.

R. Brightman.

GEOLOGICAL TEXT-BOOKS

Lake and Rastall's Text-Book of Geology

Revised by Dr. R. H. Rastall. Fifth edition. Pp. viii+491+32 plates. (London: Edward Arnold and Co., 1941.) 25*s*. net.

Introduction to Geology

By Prof. E. B. Branson and Dr. W. A. Tarr. Second edition. Pp. ix+482. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 26*s*.

Field Geology

By Dr. Frederic H. Lahee. Fourth edition, revised and enlarged. Pp. xxxii+853. (New York and London: McGraw-Hill Book Co. Inc., 1941.) 35*s*.

EVER since its appearance more than thirty years ago, "Lake and Rastall" has been recognized as our leading elementary text-book on geology. Now, in its fifth edition, it has been carefully revised and largely rewritten by Dr. Rastall. While the general plan remains unchanged, the balance of the various topics has been improved and the treatment modernized. Some sections have been shortened or omitted (for example, certain details of mineralogy and petrology) to make room for new matter concerned with subjects in which there has been considerable recent progress, as in the chapter on sedimentary rocks. In revising the stratigraphical chapters, the admirable regional handbooks issued by H.M. Geological Survey have been fully utilized.

Here and there revision has perhaps not gone far enough. Neither the intrusive masses of the Cuillins and Red Hills of Skye (p. 247) nor the granite intrusion of the Cheviots (p. 475) should now be considered as laccoliths. In the classification table on p. 263 there is still no indication that plagioclase is an essential mineral of alkali-gabbro. The old interpretation of the nickel ores of Sudbury as segregations of immiscible sulphides (p. 265) is no longer tenable, since the ores are now known to be of later origin than the basic rocks with which they are associated. In connexion with the emplacement of igneous rocks there is some confusion on p. 264 between melting and overhead stoping, while the use of the term "melting" (pp. 13 and 250) hides the fact that granitization involves a change of chemical composition. However, these are minor defects, mostly inherited from earlier editions.

A particularly laudable feature of the book is the refreshing absence of dogmatism and the frank recognition that many of the hypotheses concerning fundamental problems are still little more than speculative. "Lake and Rastall" has always been esteemed for the broadness of its scope, the clarity of its style and the unfailing interest of its treatment. In this new edition its high reputation should be still further enhanced.

Branson and Tarr's "Introduction", which deals with both physical and historical geology, is now, in its second edition, a far more attractive volume than before. The most conspicuous change is to be found in the illustrations; several new ones have been substituted and all of them are now very much more effectively reproduced. The revision of the text has been confined to bringing the work up to date, simplifying certain sections that were found to present difficulty, and omitting technicalities that are believed to be "beyond the comprehension of elementary students".

In some respects the result is probably too simple for a first-year university course. It is claimed that igneous rocks can be determined by means of a cross classification based on (*a*) colour and mineral composition—light and dark in each case, against (*b*) structure—grained, dense, glassy and fragmental. Fig. 9 brings together all the common modes of occurrence of igneous rocks in a most unnatural and misleading association. Sedimentary and metamorphic rocks are dealt with more adequately and, allowing for the limited scope of the book, the general treatment of the physical agents is good.

The historical chapters, based on the stratigraphy of North America and including sections on the development of life and also on the chief economic products of each system, are necessarily sketchy; nevertheless a broad picture of essentials is gradually built up. The book is not well adapted to the needs of British students, but teachers will find the method of presenting the subject to be of considerable interest.

For a quarter of a century Lahee's "Field Geology" has been a widely appreciated standard manual for field geologists and engineers. The first part of the book is concerned with the recognition and interpretation of geological structures and topographic forms. A particularly valuable feature is the careful discrimination (often well summarized in tables of criteria) between superficially similar phenomena which may be of diverse origins. The second part deals with such topics as methods of surveying, construction and interpretation of maps, geological computations and preparation of illustrations and reports. There are many tables of practical value and the bibliography and index are both excellent.

In the new edition, the fourth, much new material has been incorporated by revision and expansion, notably on the structures of igneous and metamorphic rocks, the analysis and classification of folds and faults, and sub-surface and aerial methods of surveying. The chapters on aeroplane mapping and geophysical surveying have been rewritten and enlarged to embody the chief advances made during the last decade. There is no systematic treatment of groundwater or water-supply problems, but the volume is already so long and so packed with useful information that it will probably seem ungracious to ask for more. The new edition may be cordially recommended to all practical geologists and mining engineers, and it should certainly be acquired for the shelves of every geological library.

PLASTICS AND THEIR USE

Plastics in Industry

By "Plastes". Second edition, revised. Pp. xiii+248+45 plates. (London: Chapman and Hall, Ltd., 1942.) 15*s*. net.

SOON after the close of the War of 1914–18 there began to be talk of the plastics industry. Few knew what this indicated, excepting that it was possible to take certain condensation products made from simple substances and mould them into permanent objects with the aid of heat. The progress made in the last twenty years has been amazing; a yard-stick for its measurement was afforded by successive British Industries Fairs. On the purely chemical side there have been developments of two types: the discovery and manufacture of simple substances to use as condensing agents, and the understanding of the theory and practice of condensing to form large molecules of the desired size. There is now an abundant literature on this subject.

The plastics industry is developing on the lines that one firm makes the condensation products and perhaps their raw materials, while another undertakes the moulding. It is this section which is becoming so widespread as the use of plastic materials increases. The book before us is devoted to the moulding industry and is written to give industrialists in general a picture of what plastics are and what can be done with them. The claim is that they are easily moulded into complicated shapes and can be given properties of outstanding advantage. The synthetic chemist has enriched the world with dyes, drugs, solvents and many organic substances in daily use. In plastics he has made a further step forward in providing materials of construction which compete with wood and metals.

There are two types of plastic based on different raw materials, namely, those which can be re-softened by heat and re-moulded, generally called thermoplastics, and those which remain rigid and hard when once moulded, known as thermosetting. The technique of their fabrication, a purely engineering industry, is becoming complicated. It includes blowing or shaping, extrusion through nozzles or dies, compression moulding and injection moulding.

The book describes the technique in sufficient detail and goes on to deal with the applications of the articles made in the engineering, chemical and electrical industries.

In these days when so much depends on aircraft, there is no need to emphasize the importance of light-weight materials, and plastics have become available for many unstressed and lightly stressed parts at one time made of light alloys. Plastics in aircraft construction have become a science and industry on their own.

What the modern motor-car owes to plastics is well known; more recent is the relation to the textile industry. We have at last, in 'Nylon', a wholly synthetic fibre made from highly complicated condensation products of a nature such that the final substance does have an affinity with protein. The 'Nylon' fibre owes much to the fact that at one stage of its manufacture it is cold drawn—yet another example of the co-operation between engineer and chemist.

The possibilities of plastics in the building and furniture industry are obvious: they will figure largely in the house of the future, provided the masses learn to take more care of what does not immediately belong to them.

The book goes into many other applications with just sufficient detail to illustrate the potentialities and whet the appetite of the reader.

Plastics have one great advantage, their raw materials are largely indigenous, so that the establishment of a virile industry in Great Britain depends on the chemists and the enterprise of the industrialists. It should develop to a very large and remunerative industry giving employment to a skilled person.

E. F. ARMSTRONG.

STARLING MOVEMENTS AND THE SPREAD OF FOOT-AND-MOUTH DISEASE

By DR. W. S. BULLOUGH
University of Leeds

A CONNEXION between the erratic and inexplicable occurrence of foot-and-mouth disease and the movements of wild animals has been suspected for a long time, and in the annual Reports of Proceedings under the Diseases of Animals Acts, published by the Ministry of Agriculture and Fisheries, frequent references are made to the possibility that certain outbreaks of disease were due to the presence in the infected area of unusually large numbers of such birds as rooks, gulls, or starlings. The first serious attempt to correlate the movements of birds with the spread of the disease appears to have been that of Stockman and Garnett[1], but their work was strongly criticized, mainly from an ornithological aspect, by Thomson[2]. They did, however, make the valuable suggestion that the only obvious way in which the disease can be transmitted over large distances, often apparently in a very short time, is through the agency of birds, and their ideas have formed a basis for a new survey of the problem now in press in the *Proceedings of the Royal Society*[3]. This survey has been made possible by a study[4] of the breeding behaviour of the British and Continental races of the starling, *Sturnus vulgaris* L., and it consists of a correlation of this new knowledge with an analysis covering nearly forty years of the records of foot-and-mouth disease in the British Isles and on the Continent.

The migrations and movements of all the species of birds studied by Stockman and Garnett have not been considered again in the present survey. Attention has been focused on the starling alone, as this species is extremely numerous, normally frequents and feeds on pasture land, and is closely associated with farms and with cattle. The birds, keeping together in large companies, excavate their food from the ground, and for reasons not yet explained, they prefer to feed in the immediate vicinity of the noses and feet of grazing animals and often perch on their backs. If the normal food source fails due to frost or snow, starlings commonly flock into the cattle sheds and feed in hundreds from the feeding troughs. Although there are other species of birds with similar habits to these, there is no other present in such enormous numbers and which moves about Great Britain in such large flocks.

The first problem to be considered is that of the introduction of foot-and-mouth disease into Great Britain. Unless a natural reservoir of disease exists in some wild species within the British Isles, it appears that such introduction must take place, because each epidemic is so vigorously suppressed, and it is possible that the virus may be imported by Continental starlings on migration in autumn. In this connexion it is important to note that the native British starling is almost entirely sedentary, and therefore cannot be concerned at this stage. Hundreds of Continental starlings have been ringed on the Continent in summer and recovered in the British Isles in winter, or marked here in winter and recovered in their native countries in the breeding season. Analysis shows that of ten birds natives of Norway, seven were reported in Scotland and only one in Northern Ireland and two in England, whereas of 563 birds coming from or going to Continental countries other than Norway, 559 were reported in England, Wales and Ireland and only four in Scotland. The numbers of marked birds moving between Norway and Scotland are unfortunately only small, but nevertheless it appears that the migrating Norwegian starlings tend to winter in Scotland while the other Continental starlings come to England, Wales, and Ireland. Probably two separate migration routes are used, the birds from the countries bordering the Baltic being prevented from entering Norway, and so crossing to Scotland, by the mountain chain which marks the western boundary of Sweden. This conclusion is significant because foot-and-mouth disease is rare in both Norway and Scotland, whereas it is common in England, Wales and Ireland and in such countries as Sweden, Denmark, Germany and Holland, whence come most of the starlings which arrive each autumn on the east coast of England. It is interesting to note that when an unusually large epidemic starts on the Continent it appears to spread to England at the autumn migration time. This was true in 1925 and 1926, and again in the autumn months of 1930 and 1932.

The spread of foot-and-mouth disease inside the British Isles may also be due to birds, and here again the starling has a striking habit, namely its tendency to roost communally in enormous numbers in a plantation or reed-bed. All the birds within about twenty-five miles of such a place fly there each night to sleep. Opportunities for the spread of a virus inside a roost are great as the birds pack closely together shoulder to shoulder, and next morning it is possible that the disease may be taken for many miles in some new direction. The strength of the urge for communal roosting varies with the seasons. British starlings indulge most strongly in the habit from June to December, in which month a close attachment to the nesting places begins. Immigrant Continental starlings roost communally from September to March, which is the entire period spent in the British Isles. The numbers of birds present in the roosts in each month of the year give an indication of the numbers travelling daily across the country, and therefore they may also give an indication of the probability that a disease will be spread. Counts were made each month of the numbers of starlings frequenting two roosts in the neighbourhood of Leeds, and the results were checked by observations on seven other roosts.

TABLE 1. APPROXIMATE AVERAGE NUMBERS (IN THOUSANDS) OF STARLINGS OCCUPYING COMMUNAL ROOSTS IN THE NEIGHBOURHOOD OF LEEDS.

1939										1940	
Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
10	1	4	25	35	15	25	50	65	70	35	30

These figures are compared in Graphs 1 and 2 with the monthly numbers (Table 2) of unexplained outbreaks of foot-and-mouth disease, and it is seen how close is the correspondence.

TABLE 2. NUMBERS OF UNEXPLAINED OUTBREAKS OF FOOT-AND-MOUTH DISEASE IN THE BRITISH ISLES BETWEEN 1900 AND 1937.

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
42	30	19	16	8	12	22	15	31	54	53	47

Both graphs rise and remain high in the autumn when millions of starlings arrive from the Continent to reinforce the local population. Extremely large numbers of birds are then moving backwards and forwards across the country each day. The fall in both graphs from December to February may be correlated with the fact that at this time most adult

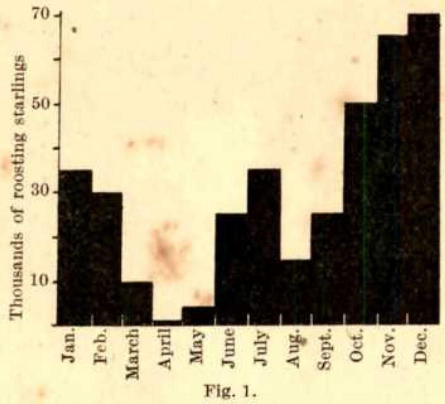

Fig. 1.

AVERAGE NUMBER OF STARLINGS OCCUPYING COMMUNAL ROOSTS IN WHARFEDALE IN 1939 AND 1940.

British starlings remain to roost in their nesting holes, so that the daily movements of birds are considerably reduced. In March the Continental birds leave for their breeding places, and the roosts, then mainly occupied by first-year and non-breeding males, reach a minimum size. In June the parents and newly fledged young return to sleep communally and both graphs rise steeply as big daily starling movements are resumed. A peak is reached in July to be followed by a fall which, at least in the case of Graph 1, appears to be connected with the serious weakening of the power of flight during the August moult of the flight feathers. An exceptional case was discovered of a bird which was hardly able to fly at all[5]. In September the new flight feathers are fully formed, the British birds again make long daily flights, and the first Continental birds arrive.

It was considered possible that if foot-and-mouth disease is brought into Great Britain from the Continent in autumn due to starling migrations, and if the birds (from countries other than Norway) arrive first on the east coast and only later spread right across England and Wales, the peak of the monthly incidence of disease might be earlier in the eastern counties than in the west. England was therefore divided into roughly equal eastern and western parts, Wales being included in the western part, and it was discovered that, in fact, the greatest monthly number of outbreaks occurred in the eastern area in October whereas the peak for the western area was not reached until November. Further, whereas in the western area the minimum incidence of disease was in April, in the eastern counties there was a small peak in that month possibly connected with the return journey across this area made late in March by birds from the western area.

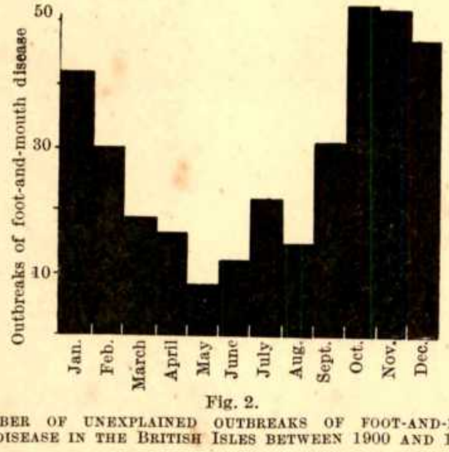

Fig. 2.

NUMBER OF UNEXPLAINED OUTBREAKS OF FOOT-AND-MOUTH DISEASE IN THE BRITISH ISLES BETWEEN 1900 AND 1937.

It has been shown that foot-and-mouth disease is most prevalent in the British Isles in autumn and winter when the starling population is at a maximum, and in order to test this correlation it was decided to study the monthly incidence of the disease in some northern country where the starling population is reduced or even absent in autumn and winter. Sweden was chosen as most suitable, and the numbers of outbreaks of disease from 1900 until 1937 were obtained through the generosity of Prof. H. Magnusson. Unfortunately, in the records no distinction was made between the primary unexplained outbreaks and the secondary outbreaks due to known causes. The figures in Table 3, therefore, refer to the total number of outbreaks, and only broad conclusions may be drawn from them.

TABLE 3. TOTAL NUMBER OF OUTBREAKS OF FOOT-AND-MOUTH DISEASE IN SWEDEN BETWEEN 1900 AND 1937.

Jan.	Feb.	Mar.	Apl.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
489	975	1396	1855	1810	1203	823	696	609	464	426	427

These figures are expressed in Graph 3, and it is immediately clear that this is a direct opposite to Graph 2 for the British Isles. There is a sharp rise in the incidence of foot-and-mouth disease in late winter, a maximum being reached in April when all the birds have returned from the south. Again, instead of a rise in autumn, the graph falls to a minimum in November and December.

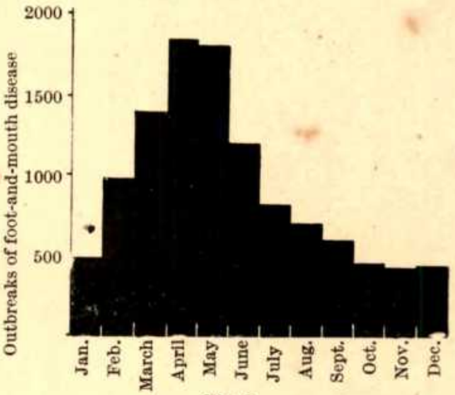

Fig. 3.

TOTAL NUMBER OF OUTBREAKS OF FOOT-AND-MOUTH DISEASE IN SWEDEN BETWEEN 1900 AND 1937.

One further line of evidence remains to be considered, namely, the geographical distribution of the starling and of foot-and-mouth disease in the British Isles. In 1932 and 1933, Marples[6] made a survey of the roosting places of the starling in Great Britain, and found that they are not usually located above an altitude of 600 ft. Of 285 roosts recorded only five were above that level. Marples considered that this is probably due to the fact that above 600 ft. there are, on the average, only rough hill pastures or heather moors, both of which habitats the starling tends to avoid. The positions of the primary unexplained outbreaks of foot-and-mouth disease were plotted to discover whether these also tended to occur below 600 ft., and it was found that of 270 outbreaks occurring between 1922 and 1937 only two were above that level. The value of this last correlation is not certain because, of course, most cattle are also found on lower land, and many of the sheep and deer which frequent the higher ground come down from the hills in the winter. Therefore, before the true significance of this correlation could be assessed it would be necessary to find the proportions of sheep and cattle above and below the 600-ft. level at all times of the year.

These various analyses provide striking, if only circumstantial, evidence of a connexion between the movements and distribution of British and Continental starlings and the incidence of foot-and-mouth disease; but there are certain facts contrary to this general conclusion which must be mentioned. In the first place, experiments with captive starlings have indicated the great difficulty of inducing birds to transmit the virus of foot-and-mouth disease, and it may be that some special condition, such as illness, is required before the bird can act as a carrier. In this connexion it will be noticed that although many millions of starlings must have entered and moved about the British Isles between 1900 and 1937, only 349 unexplained outbreaks of foot-and-mouth disease occurred in the whole period. A second point of difficulty is presented by the great epidemic of foot-and-mouth disease which appeared in Europe immediately after the period surveyed in Tables 2 and 3, and the numbers of these outbreaks, if included, would considerably alter the shape of Graph 3. In the autumn and winter months of 1938–39 there were almost as many outbreaks of foot-and-mouth disease in Sweden as in the whole of the previous thirty-eight years, and similar conditions prevailed all over the Continent. However, an epidemic of this magnitude would be expected to present abnormal features, and it seems that the spread of the disease northwards across Europe may have been due to unusual factors.

It is difficult to see how proof or disproof of a thesis that the starling is an important carrier of foot-and-mouth disease can be obtained, and certainly many factors other than the starling must be involved in greater or lesser degree. Latitude, weather, and several species of birds may exert an effect, and possibly also there exists in some species of wild mammal a natural reservoir of disease[7] although, if this last contention is correct, it is difficult to understand why many more outbreaks do not occur. At the present moment it does not seem possible to do more than put forward the suggestive but inconclusive evidence.

[1] Stockman, S., and Garnett, M., *J. Min. Agric.*, **30**, 681 (1923).

[2] Thomson, A. L., Nature, **113**, 52 (1924).

[3] Bullough, W. S., *Proc. Roy. Soc. Lond.* (in the press).

[4] Bullough, W. S., *Phil. Trans. Roy. Soc. Lond.* (in the press).

[5] Bullough, W. S., *Ibis*, **6**, 225 (1942).

[6] Marples, B. J., *J. Anim. Ecol.*, **3**, 187 (1934).

[7] Elton, C., Progress Report of the Foot-and-Mouth Disease Research Committee, **5**, 379 (1937).

CANTEEN FEEDING

By F. LE GROS CLARK and DR. N. W. PIRIE

MUCH has been written, in Nature and elsewhere, on the relative merits of research that has absolutely no practically useful end in view and of research that it is hoped will lead to improvements in practice. The latest meeting organized by the Nutrition Society was held on May 30 to consider "Problems of Collective Feeding in War Time", and it gave invaluable evidence on the ease with which nutritional and biochemical research could produce immediately useful results without coercion of the research worker or any sacrifice of interest in the more fundamental aspects of science. Few research workers can have attended the meeting without being impressed by the extent to which pure scientific research was needed as a preliminary to the solving of the very practical problems of food distribution and cooking. If more meetings can be held at which men of science have the opportunity of learning about the problems that arise in practice, it is very probable that much of the necessary practical research will in fact get done with no greater interference with the freedom of choice of the individual research worker than we had in the last years of peace. It is greatly to be hoped therefore that the Nutrition Society will organize other conferences along the lines of the one that has just been held.

Squadron-Leader J. Salmon described the standard conditions in the Royal Air Force. An aircraftman's mess can serve a thousand meals at a time; it is often necessary to have two sittings for meals because of the unanticipated growth of a station. The mess is under the control of a catering officer, if there are more than six hundred men on the station, and a mess committee; close attention is paid to the general wishes of the eaters, for no choice of food is available. The amounts of rationed food drawn by the catering officer are rigidly controlled, and he is encouraged to draw his full rations so that an average of 3,500 calories a day for each man and 2,800 for each woman can be maintained.

Experience has shown that, to avoid waste, it is best to serve moderate helpings and allow those who wish more to get further helpings. In the discussion there was agreement that catering in the R.A.F. is better than in the other Services, but that there is still room for improvement. The old adage "God sends the food but the Devil sends the cooks" seemed to sum up the view of several critics, and the sensible suggestion was made that cooks should be paid extra if only for the reason that they could then lose pay if they cooked badly. Other speakers mentioned the difficulty found in getting women with cooking experience in civil life to take up cooking in the W.A.A.F.s. in spite of the extra pay that is in fact given.

Works canteens and British Restaurants are presented with a somewhat different problem, for they do not have a guaranteed clientele but have to attract diners by the quality of the meals served. How successful they are at doing this is shown by Lord Woolton's opening statement that 94,000,000 meals a week are now served "off the ration", and by the great extension of the works canteen system. Miss I. M. Clift said that there are now 7,500 industrial canteens—five times as many as in 1940—and she described vividly the methods used in her canteen to popularize the eating of foods to which the workers were unaccustomed. The mass-psychological aspect of these canteens was also referred to by Miss M. C. Broatch in her paper on school canteens. The first principle is that a novel food should appear as an extra rather than as an alternative and that at the beginning it should be in short supply; furthermore a choice of meats and vegetables on each day and a different choice on each day of the week is an advantage. It is interesting to learn that 40 per cent of the workers in one factory choose wheatmeal bread rather than white when a choice was offered, for before the introduction of the 85 per cent extraction loaf it was often stated that the British public insisted on white bread.

Miss M. Abrahams described measurements made on the meals served in forty-one British Restaurants. The calorie value ranged from 494 to 1,797 per meal; only six gave more than 1,000 calories. The prices ranged from 8*d.* to 1*s.*, and the calories per penny from 41 to 163, with only seven Restaurants giving more than 100. Part of this variation is deliberate, for Dr. M. Pyke had already said that the Ministry of Food tried to get bigger meals served in those Restaurants that tended to cater for heavy workers, but it was suggested that much of the variation was unintentional and to be deplored. The Londoners Meals Service makes every effort to serve children with a uniform balanced meal of an agreed protein, fat and carbohydrate content, and this organization is now supplying London school-children with fifty thousand meals a day. These meals contain as much meat as the meal that works canteens serve to heavy workers; there has been some opposition to this practical appreciation of the fact that a growing child needs more protein than a normal adult, but headway is being made in most areas.

In considering the nutritive value of the food served in these various canteens most of the speakers concentrated on ascorbic acid. This preoccupation with only one out of some hundred known essential metabolites was deplored by several speakers, notably Squadron-Leader T. F. Macrae and Mr. A. L. Bacharach, but it is presumably inevitable on account of the greater difficulty with which the other minor dietary constituents can be estimated.

It was clear in the discussion of most of the papers that the academic research workers tended to turn automatically to calories, protein and ascorbic acid as the criteria of a good meal. This suggests that work should be undertaken to see whether an ordinary British meal that is adequate in these three respects is likely to be adequate in other respects also, for, if this were true, it would greatly facilitate the problem of inspection.

The various factors that lead to unevenness or inadequacy in the consumption of ascorbic acid were considered in some detail. In the first place a better selection of vegetables could be planted and more care could be taken to ensure that green-stuff is available all the year round. Prof. J. R. Marrack pointed out that, in the bulletin issued by the Ministry of Agriculture, kale is scarcely mentioned whereas considerable attention is paid to parsnips. The former is a valuable source of ascorbic acid in the spring whereas the latter is almost valueless from this point of view. With green vegetables speed is essential in distribution; a cabbage that has taken 3–7 days in getting from the field to the kitchen will have lost half its ascorbic acid in the process. The potato is more stable, but there is loss during the correspondingly longer period for which it is generally stored.

Many speakers referred to the eating of vegetables raw as a means of avoiding the losses that are often entailed in cooking. The consensus of opinion seemed to be that this would not altogether solve the problem and that it might lull the caterer, who does not consider closely what weight of material is actually being eaten, into a state of false confidence. Raw vegetables are bulky and, if served up as a salad with whole leaves, very little is actually eaten. If, on the other hand, the bulk is reduced by grating, ascorbic oxidase is liberated from the damaged leaf cells and causes serious destruction of the ascorbic acid. This destruction can be greatly minimized by shredding or slicing instead of grating, for in these circumstances the proportion of damaged cells is smaller. Even if the vegetable gets into the diner's mouth with its ascorbic acid undiminished all is not necessarily well; for Dr. M. Pyke quoted an experiment in which 19 per cent of the ascorbic acid in a sample of sliced raw cabbage was destroyed in thirty seconds' chewing and 29 per cent in sixty seconds. In the subsequent discussion it was pointed out that further destruction probably took place in the alimentary canal before absorption had taken place and that, although it is likely that the destruction is due to enzyme action, this should have been confirmed by a similar experiment with cabbage in which the enzyme had been destroyed by boiling under proper conditions.

When green vegetables are being cooked what is to be aimed at is the most rapid possible destruction of ascorbic oxidase and the smallest possible loss of minerals and ascorbic acid in the water used for boiling. Many suggestions for achieving these two desiderata were made. Macrae said that the gradual addition of quartered cabbages to the boiling cauldron of water, at such a rate that the temperature never fell below 85° C., led to the preservation of most of the ascorbic acid; whereas 80 per cent was destroyed if all the cabbage was added at once so that the whole mixture fell to 60° or 70°. Dr. R. G. Booth described the successful avoidance of this loss in some British Restaurants by using a large number of small pots that can be heated rapidly. Dr. L. W. Mapson said that a smaller volume of water could be used for cooking if the vegetables were shredded first and suggested that the outside leaves of cabbage might be boiled in the water first and then removed before adding the shredded cabbage. By this means the cooking would be done in dilute ascorbic solution. The value of this suggestion depends on a number of quantitative factors that cannot be assessed on the spur of the moment in a meeting and there was no further discussion of the point. Several speakers pointed out that the extraction of ascorbic acid and minerals was only objectionable if the water were then thrown away but that it did not matter if the same water was used over and over again for boiling vegetables or if it was afterwards used for making soup or gravy; both procedures are in fact followed in many establishments.

If the problem of cooking large amounts of vegetables without serious loss of ascorbic acid has been surmounted, there is still an opportunity for loss if the food is kept hot for long before it is consumed. Mr. F. Le Gros Clark described the Russian pioneer experience in this field. In 1925 central kitchens sent out cooked food, in insulated containers, to factories, but this system was given up progressively from 1931 and thereafter they sent out food prepared and ready for cooking. This change is in accordance with British experience during the last few years and several speakers condemned the insulated container. Dr. Pyke found that after 2½ hours about half the ascorbic acid present in cooked greens or potatoes had been lost, but he pointed out that the final product might well be better than badly cooked vegetables prepared on the spot. It is clearly impossible to do all the cooking in a large canteen or mess immediately before the meal is served; and the cooks and catering officers should therefore be advised which foodstuffs are but little damaged by being kept hot until the rest of the meal is ready and which are seriously damaged. Several speakers mentioned the readiness with which scientific advice on these matters was accepted by cooks and catering officers.

The proceedings of this most successful conference fell into three parts: first, the organization and method of control of canteen feeding; secondly, the stability of ascorbic acid under the conditions of large-scale cookery; and thirdly, a buffet lunch in the production of which at least some of the principles on which there had been substantial agreement seemed to have been borne in mind.

DEGENERATION AND RELICT ADAPTATION

By PROF. JULIAN HUXLEY, F.R.S.
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RECENT advances in biology have shed considerable light on the evolutionary fate of originally adaptive structures which have since become functionless. It is a commonplace that in the great majority of animals such organs degenerate and either disappear entirely or become vestigial, while often showing excessive variability. This tendency to degeneration (and excess variation) of functionless organs appears to be automatic in sexually reproducing organisms with any considerable degree of outbreeding, like the great majority of higher animals. In such cases, as Muller[1] has pointed out, mutation-pressure alone will tend to cause useless organs to degenerate. Sewall Wright[2], while agreeing with this view, believes that a more important factor operating in the same direction is the prevalence of multiple-factor (polygene) systems of genes with multiple (pleiotropic) effects, in the genetic make-up of organisms. Wherever this is so, "the evolutionary changes in a system of genes, some bringing increased development and others reduced development in those parts of the organism which are under direct selection, should have a net effect on *indifferent* parts in the direction of reduced development". Further, when linked polygenic systems exist (that is, polygene systems consisting of one or more sets of genes which show genetic linkage with each other) and two such systems are lodged in the same chromosome or chromosomes, then anything which promotes change in the one will, by virtue of the resultant general recombination, promote change in the other. Thus, if selection is acting to alter the main character controlled by one such system, while the character controlled by the second is selectively neutral or useless, the resultant recombination will 'break up' the useless character, and in virtue of the obvious tendency of change to be towards decreased efficiency unless kept up to the mark by selection, this will promote degeneration of the useless feature. Degeneration of useless organs is thus genetically inevitable, partly as the direct effect of mutation pressure, partly indirectly as a by-product of selection acting on polygene systems with multiple effects.

None of this reasoning, however, should apply in the case of organisms which do not practice outcrossing, that is, species (mostly plants) with complete obligatory self-fertilization, parthenogenesis or apomixis, or exclusively vegetative reproduction. For one thing, in them the recombination of 'loss' mutations is no longer possible, and in its absence degeneration should only be able to proceed with extreme slowness. Furthermore, since many loss mutations are deleterious to general viability, it seems probable that they need buffering to survive, and for this again recombination is necessary, so that where recombination is impossible, mutant characters of this type will be automatically eliminated.

The result should be the opposite of that found in most higher animals, namely, the complete or almost complete persistence of originally adaptive structures in spite of their having become wholly functionless—'relict adaptations', one might call them.

The most natural place in which to look for such organs would be among the floral mechanisms of such higher plant species as have abandoned outcrossing for compulsory self-fertilization or apomixis. At first sight there would appear to be numerous examples of this. For example, in various genera of Compositæ such as the dandelions (Taraxacum) and the hawkweeds (Hieracium), there exist a number of forms which appear to produce all their seed by obligatory apomixis. Yet in spite of this they continue to produce an abundance of showy flower-heads, obviously adapted to attract insects.

It might, however, be objected that the persistence of these erstwhile adaptations was due to the short time which had elapsed since the type had changed over from normal sexual reproduction to apomixis. We know of such instances in animals. For example, in the spruce sawfly Gilpinia (Diprion), there are two extremely close 'biological races' or species of which one shows obligatory parthenogenesis, while in the other parthenogenesis alternates with sexual reproduction (Balch, Reeks and Smith[3]). There can be no doubt that here obligatory parthenogenesis is a very recent acquisition, so that we should not be surprised at the persistence of organs subserving sexual reproduction, such as the spermatheca in the females, or the testes in the occasional but functionless males produced. However, in Taraxacum, Dr. W. B. Turrill informs me that apomixis may well date back at least ten thousand years, to the period when the ice was retreating.

On the other hand, there is a more serious objection to considering flower-heads such as those of dandelions as relict adaptations, namely, the presence of numerous 'correlated characters' which might still be regarded as having functional significance even after the main (entomophilous) function of the capitulum had been lost. Various parts of the mechanism must be useful in providing the developmental scaffolding for the production of the pappus, which is, of course, highly adaptive in regard to the dispersal of the (apomictic) seeds, and the long ray florets still play a part in protecting the central parts of the head during its closure at night, though this protection itself may perhaps be a relict adaptation, as it probably concerns the pollen. However, such considerations do not seem to apply in some of the obligate apomicts in grasses, where the floral mechanism was adapted to anemophilous cross-pollination, and yet survives its loss of function.

Still another complication exists, in the shape of the segregation which we now know to occur in various apomicts (Crane and Thomas[4]). This is due to crossing-over, the apomictic embryo presumably arising after the first meiotic division. This asexual segregation may well have been responsible for some of the swarms of forms found in apomictic groups. It will also give a certain amount of recombination, which in its turn will facilitate a certain amount of degeneration.

Another apparently good case, unless the change of reproductive method is very recent, is provided by the coral-root *Dentaria bulbifera*, which reproduces entirely by bulbils, but continues to make the unnecessary gesture of producing obviously entomophilous flowers, which further do not seem to have any subsidiary non-sexual function as in Taraxacum.

The complexity of the phenomena is well illustrated by the lesser celandine, *Ranunculus Ficaria*. Here, as Marsden-Jones[5] has shown, two varieties co-exist in Britain, one reproducing sexually, mainly by cross-pollination, the other (var. *bulbifera*, a tetraploid form) mainly vegetatively, by means of bulbils. However, in this latter form a small percentage of viable seed may be produced, apparently by cross-pollination. Furthermore, the mean width and number of its petals and the mean number of its stamens are slightly reduced. If this should not be a consequence of tetraploidy, it is evidence of incipient degeneration of these relatively useless organs—a degeneration made possible by their small residual function. Dr. W. B. Turrill tells me that similar floral degenerations are associated with apomixis in Alchemilla, indicating that here too some degree of recombination is still possible.

Obligatory self-pollination would bring about the same genetic result as obligatory apomixis. Here, however, the difficulty is to find satisfactory examples, since in the great majority of cases self-pollination is not completely obligatory and a certain fraction of seeds result from outcrossing. Thus the orchis *Epipactis leptochila* is normally self-pollinating, but cross-pollination appears to be possible for a brief period (Godfery[6]). The closely related *E. latifolia* is exclusively cross-pollinated. However, Dr. Mather informs me that the common tomato (*Solanum lycopersicum*), which has been investigated for many years at the John Innes Horticultural Institution, shows no cross-pollination at all in Great Britain (save in one anomalous structural variety). Yet the obviously entomophilous flowers persist in spite of this, and in spite of never being visited by insects.

In some strains of cereals, the frequency of cross-pollination is only 2 per cent, and it would seem that a rate as low as this should enormously reduce the speed at which degeneration might occur; but in other strains the cross-pollination rate may be considerably higher. The fact that forms like certain species of Taraxacum have abandoned incomplete self-pollination for obligate apomixis would indicate that the amount of cross-pollination previously possible was interfering with the immediate advantages obtainable by reduced outbreeding.

A prima facie case thus seems to be made out for the failure of degeneration to occur, with the consequent persistence of 'relict adaptations', whenever cross-breeding is absent and perhaps when it is markedly reduced. However, the phenomena are often exceedingly complex, and the interpretations of floral mechanisms by earlier writers have often been coloured by a somewhat uncritical armchair Darwinism. Thus, a good deal more investigation is required before this interesting theoretical deduction can be regarded as confirmed.

In conclusion, I would like to thank Prof. E. J. Salisbury, Dr. W. B. Turrill, Mr. John Gilmour, Dr. C. D. Darlington, Mr. E. B. Ford, and especially Dr. K. Mather, for their help and advice.

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[1] Muller, H. J., *Biol. Rev.*, **14**, 261 (1939).
[2] Wright, Sewall, *Amer. Nat.*, **63**, 274 (1929).
[3] Balch, R. E., Reeks, W. A., and Smith, S. G., *Canad. Ent.*, **73**, 198 (1941).
[4] Crane, M. B., and Thomas, P. T., Nature, **143**, 684 (1939).
[5] Marsden-Jones, E. M., *J. Linn. Soc. Lond.*, (Bot.), **50**, 39 (1935).
[6] Godfery, M. J., "Monograph and Iconograph of British Orchidaceæ" (Cambridge, 1933).

MODERN SCIENCE AND THOMAS HOBBES

By A. E. BELL

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THREE hundred years ago appeared the first of Hobbes's chief philosophical works, his "De Cive". The "Leviathan" followed in 1645, the "De Corpore" in 1655 and the "De Homine" three years later. Few scientific men would claim to read these works to-day, and in the history of science Hobbes is usually given little notice. 1642 is famous rather as the date of Galileo's death and Newton's birth. The scientific movement was at this time gaining momentum; scientific societies were springing up in Florence, London and Paris and gaining the support of men of wide interests as well as the 'mathematical heads'. Evelyn and Pepys, Chapelain and Perrault illustrate the general appeal which science then made. "This is the age," wrote Power, "wherein methinks, philosophy comes in with a spring tide."

This natural philosophy was not regarded as threatening existing ideas; poets and divines were among those who hailed the discoveries of science as opening out new vistas to the human spirit. Bacon's new world indeed seemed to be in sight. "It is the great prerogative of Mankind above other creatures," wrote Hooke in 1665, "that we are not only able to behold the works of Nature, or barely to sustein our lives by them, but we have also the power of *considering, comparing, altering, assisting* and *improving* them to various uses." Science was regarded as a study of phenomena which could yield a measure of control over man's environment. Even in the seventeenth century, however, it was becoming clear to men like Huygens, Newton and Boyle that practical control was to be looked for rather as the inevitable by-product of the amassed theoretical knowledge—the 'intellectual control'—than as the immediate aim of research.

From all this inquiring and empirical spirit of the seventeenth century Hobbes came to be alienated by an unfortunate though perhaps inevitable combination of character and circumstance. For years he was on close terms with Mersenne and some of the greatest natural philosophers of the Continent; he was a friend of Bacon and he met Galileo. But Hobbes's acquaintance with the men of science came rather late and his studies never adequately prepared him for active work, especially in mathematics. Yet, like his contemporary Descartes, he felt a desire to generalize the conclusions of science where possible and to demonstrate its relation to other fields of knowledge. Descartes had the merit of stimulating research and of being a mathematical genius. Hobbes had far less equipment and committed inexcusable blunders in his attempted innovations in science and mathematics. Nevertheless we have in his best work, as Prof. Burtt has remarked, "the first important attempt to apply the new assumptions and method of Galileo universally". Unfortunately, Hobbes's errors were relentlessly exposed by Wallis, a great mathematician and a formidable opponent. The feud which developed lasted to the end of Hobbes's long life and effectively alienated him from the English men of science. The members of the Royal Society, he suspected, were banded together against him, and in time, polemic and ridicule and the resort on both sides to political accusations made this almost the case.

The result was to draw from Hobbes some radical criticism of the fundamental ideas employed in scientific writing. Hobbes carried to its logical conclusion the criticism of secondary qualities begun by Galileo. Denying the real existence of all secondary qualities such as colour, sound and odour as Galileo had done, he went on to assert that space and time themselves were mere 'phantasms'. He made a distinction between space and geometrical extension, the latter only, in his view, being an essential characteristic of a body. Time for Hobbes was "the phantasm of before and after in motion": "The present only has a being in Nature; things past have a being in the memory only; but things to come have no being at all . . ."

The men of science were critical of *a priori* speculations but Hobbes's attacks enforced the use of words in a narrow scientific sense, a change for which Hobbes will always be held as partly responsible. His own style was whetted and sharpened on the grindstone of scientific and logical polemic. The mathematical concept of featureless time and the scientific notion of cause were among the ideas which became more explicit. Over the definition of cause Hobbes may be held to have forestalled Hume, for he swept aside all notion of a final cause and equated cause with the sum of the antecedent conditions.

Hobbes's determination to be clear-headed made him a convinced nominalist. Particular objects only had a real existence, and words corresponded to mental images of things. Reasoning, he supposed, was explicable as a succession of images the order of which resulted from the operation of forces of the same nature as those operating in the world of corporeal things. Carried to an extreme, it could be held that true propositions about the world might be evolved out of the proper use of a symbolic language. Such a language was sought by Bishop Wilkins, but many were sceptical about Hobbes's materialistic explanation of the mind and limited mechanical causation to the physical world. For Hobbes the whole of Nature was a closed system in which the changes of configuration were completely determined by the laws of impact of the ultimate particles of which everything was composed. In the eighteenth century Condillac continued Hobbes's materialism. Science, in his view also, was only "une language bien faite". It is worth remembering that Diderot was one of Condillac's most celebrated pupils.

At this point it should be stated that the seventeenth century men of science were more influenced by Gassendi than by Hobbes. Earlier than the English philosopher, he put forward a materialistic atomism of a sufficiently crude nature. Through Huygens and Boyle, however, his ideas were spread and became especially important in chemistry. The great developments in chemistry came in the second half of the eighteenth century, and this, under the leadership of Diderot and the Encyclopædists and of Voltaire, was a materialistic era. Hobbes, though his position was fundamentally similar to that of Gassendi, had little influence over contemporary men of science. He professed great contempt for their ideas and even attacked their empiricism: "Experience concludeth nothing universally". It may be remarked that Galileo was not primarily an experimentalist and that the attitude to experiment had undergone some change with the growth of the scientific societies. Nothing illustrates Hobbes's dictum better than the contents of his "Dialogus Physicus sive de Natura Aeris" (1661) written in criticism of Boyle's work "New Experiments Touching the Spring of the Air" (1660). Hobbes there claimed that he had years before derived all Boyle's conclusions by reasoning from first principles. The weakness of such a position was not apparent to him; he did not see the force of the Royal Society's motto *Nullius in Verba* adopted a few years later. Because of this lack of comprehension and the obstinacy with which he defended his attitude, Hobbes, even in his advancing years, was an object of ridicule to Hooke and others. According to Hooke, writing of an encounter with Hobbes at a telescope-maker's, the philosopher was found "to lard and seal every asservation with a round oath . . . to have a high conceit of his own abilities and performances, though never so absurd and pitiful, etc." Hobbes, he said, asserted "that a common spectacle glass was as good an eye-glass for a thirty-six foot glass objective as the best in the world, and pretended to see better than all the rest, by holding his spectacle in his hand, which shook as fast one way as his head did the other, which I confess made me bite my tongue"[1].

Hobbes's contribution to scientific thought, however, has been important in spite of his professed indifference to scientific studies and his personal hostility to the English men of science. By trying to reduce all phenomena to the one cause of material impact between ultimate particles, he carried to an extreme a 'legitimate' materialism employed by the scientific men themselves. The need of other causal mechanisms, notably wave theories of sound and light, at first weakened the claims of such a view. It became clear that the scientific mode of *cause* is *force* and of this there appeared to be many kinds. It was only with the development of the concept of energy and work done that a return to a unified scheme appeared possible.

Huygens in 1693 gave the first clear statement of the principle of conservation of energy in mechanical systems[2], and the idea was developed by Daniell Bernoulli and Thomas Young. Rumford, Gay-Lussac, Sadi Carnot and Julius Mayer then paved the way for Joule's establishment of the general law of conservation of energy. The publications of Kelvin and Helmholtz popularized the concept of energy while Coriolis and Poncelet completed the system of physics required in engineering by introducing the term *work*. By the end of the nineteenth century it seemed as if the cycles of matter and energy were closed; the outlook of Hobbes had returned. So long ago as 1780 Lavoisier and Laplace had shown the equality of the heat generated by oxidation of carbon inside and outside the animal body. With the successful extension of physical and chemical principles to biology in the nineteenth century, it began to look as if the closed cycles existed indifferently in the organic and inorganic worlds.

Insufficient attention seems to have been given to the intellectual influence of chemistry in the nineteenth century. This was in fact the dominant science in industry after about 1860, and it was difficult to resist the suggestion that it was the science which could throw most light on the ultimate nature of matter. The stereo-chemical theory built up Pasteur, van't Hoff, Kekulé and others, for example, encouraged a visual imagery which all subsequent research proved to be correct in essentials. There seemed to be little doubt about the material nature of molecules; such work as that of Perrin disposed of that. Indeed the whole tradition of chemistry is materialistic, and experiments such as those on the artificial transmutation of elements are most commonly treated from this point of view. The problem of steric hindrance is perhaps the best example of the old outlook coming into contact with the new.

It is well known that chemists tend to adopt materialistic forms of physical entities ("when chemists talk about electrons they use a different language from physicists"); and if this is true to-day, it was so much the more difficult to escape from materialism in the nineteenth century. "For no man can live in the external truth among acids and salts", wrote Stevenson, "but in the warm phantasmagoric chamber of the brain with the painted windows and the storied wall". Stevenson could not have anticipated the phenomenalism of Mach and Karl Pearson which averted this antithesis. This was the view that the doctrine of determinist mechanism only applies to the abstract entities provided by logical analysis. Phenomenalism has never been adopted universally by scientific men, and in the nineteenth century the rift between science and philosophy encouraged the retention of a naïve realism.

Now that men of science show a renewed interest in certain philosophical problems, new opportunities have arisen for investigating the consequences of adopting the phenomenalist or realist position. The limitations of a method of abstraction would appear to incline one to phenomenalism. The only point on which one finds substantial agreement among scientific writers is that science can give us only a network of relations, and the search for the ultimate nature of substance is likely always to be fruitless. We discover relations, but the *relata* are defined by the relations and nothing else. In spite of this, arguments are adduced by some writers to support a scientific form of Berkeleyan idealism. The cycles of determinism which chain the mind are then broken by invoking a form of Heisenberg's uncertainty principle which has not yet gained universal approval. Human aim and value appear to be permitted simply because, as J. W. N. Sullivan explained, the cycles of determinism at present exist only in what is called 'field' physics. In the remainder of phenomena one supposes the quantum jumps are indeterminate in the sense that they cannot be fully predicted. As is well known, this is not to say they are outside any causal nexus, for we know the set limits of the effects.

The result is bleak and cheerless enough as the basis of a 'humanistic' outlook. Ethical and æsthetical considerations may still be valid, but they seem to be left over with a rather apologetic air. The whole position is Hobbesian: science, instead of being an instrument for reducing our apprehension of the world to forms providing increased control, is regarded as disclosing the nature of an objective and pre-existent reality "in its linkage to consciousness". Because there are difficulties in the old 'spectator' theory of observation, the mind is enmeshed in the determinist (or indeterminist ?) scheme. If one favours ultimate determinism it is easy for the ordinary man to relapse into pure Hobbesian materialism; if one seriously tries to adopt some kind of objectivized chance, the character of Nature appears lunatic and its 'order' is only another of those illusory ideas which need exposing. On either basis it is difficult to see how science can intellectually be other than an obstacle to its own application to ethical ends. Both in education and in adult thought this is surely the greatest problem of modern times.

GEOPHYSICAL METHODS IN GEOLOGY

A JOINT meeting of the London and Home Counties Branch of the Institute of Physics and the Geological Society of London, held on April 22, provided a useful review of the principal geophysical means now available to supplement the routine methods of geological survey. Prof. O. T. Jones opened the meeting with a brief account of the four main types of geophysical survey, which measure respectively the ground resistivity, the rate of transmission of an artificial seismic vibration and the gravitational and magnetic fields at the surface. He stressed the importance of close co-ordination between the two sides of the subject: geology might indicate the probable materials and structures, but confirmation of their actual existence and a closer estimate of their position could in many cases be best obtained by geophysical means.

It was clear that no general preference can be given to any one method. Each has its own range of suitability and its limitations, some of which were outlined in Dr. J. M. Bruckshaw's contribution. His warnings might perhaps be specially recommended to the notice of non-physicists, for complaints as to the 'failure' of geophysics have not uncommonly arisen from the quite impossible expectations put forward by uninformed critics. There are at least as many inaccessible problems in geophysics as in geological surveying; fortunately, they are not the same problems in each case.

The principal limitations arise from the necessity for adequate physical differences between the rock masses, and from instrumental difficulties. Dr. Bruckshaw pointed out that gravitational and magnetic surveys are largely differential, depending upon local irregularities in the field, produced by discontinuities in the geological structure. Thus they are particularly adapted for detecting faults, boundaries, etc., while the presence of a uniform flat-lying bed would only produce zero (or constant) anomaly. But in practice some of the other methods have been used differentially to locate discontinuities even if the exact interpretation of the records is obscure. Another, and very interesting, point was the contrast between the Eötvös torsion balance and the gravimeter: for the former the values observed depend upon the inverse cube of the depth; for the latter, upon the inverse square. If the size of the structure increases proportionately with the depth, the effect to be observed with the torsion balance remains the same whatever the depth, while with the gravimeter the effect increases with the dimensions. Thus the torsion balance is in this respect better suited for shallow structures.

First-hand accounts of geophysical work in the field were given by Dr. D. T. Germain-Jones, who dealt with seismic exploration in Iran, and Dr. A. F. Hallimond, who described the magnetic work of the Geological Survey of Great Britain.

In using the seismic refraction method in Iran, the recording instruments were placed along an arc at about ten miles from the explosion point. The object of the survey was to locate an anticline believed on geological grounds to exist in the oil-bearing Asmari Limestone, which is concealed beneath the Lower Fars Series. This first conclusion was not confirmed, but further seismic observations to the south-west led to the discovery of an anticline in the limestone, concealed beneath a syncline in the surface rocks.

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[1] "Œuvres Complètes de Christian Huygens", 4, 381.

[2] *ibid.* 18, 554

This was confirmed by drilling, at a depth in agreement with the geophysical estimate, but only half that expected from neighbouring geological data. The peculiar structure is believed to be due to plastic deformation of the Lower Fars beds, which have been squeezed out above the Asmari anticline and thickened on either side.

The Geological Survey of Great Britain has employed magnetic methods at intervals since 1928. The range is restricted by the non-magnetic nature of most sedimentary rocks, but on the other hand the same fact allows a particularly satisfactory investigation of any underlying magnetic formations. A striking example of this was provided by the Survey mapping of the Melton Mowbray magnetic anomaly. The resulting contoured vertical force map bore practically no relation to the surface geology (Lias and Trias) but showed a remarkable magnetic 'high' area, with subsidiary ridges, such as might be due to igneous masses in the floor of older rocks. As a well-known French writer has observed: "la géophysique voit flou"; from east to west the outlines in the magnetic map become sharper until a system of ridges with east-north-east trend links up with the anomaly due to the exposed intrusive igneous mass at Mount Sorrel. The estimated depth of the floor is from 1,500 ft. to 500 ft. across the Melton anomaly.

Oil geology has afforded perhaps the most spectacular examples of success in geophysical exploration. Indeed, the value of the new oilfields discovered has tended to obscure the large number of explorations carried out on equally adequate grounds but which happened to yield negative results. They are sometimes described as failures, but they are in reality an essential part of the research. Obviously, researches cannot be limited entirely to 'successful' results, yet in the larger commercial departments programmes are designed in the expectation of only a few per cent of even moderately 'successful' results.

A clear account of some of the outstanding geophysical achievements in oil geology was contributed by Prof. V. C. Illing. Here the geological structures are chiefly anticlines or domes, and the principal methods employed are (1) seismic reflexion, for gently sloping structures, (2) torsion balance and seismic refraction, for steeper-sided salt-dome structutes, (3) gravity, refraction and reflexion in faulted and folded areas. Prof. Illing again stressed the need for co-operation in work which has for its ultimate object the presentation of a picture that is geological rather than physical. In conclusion, he described the successful employment of the Schlumberger method for correlating strata in boreholes. Electrodes are lowered down the boreholes and the resistivity of the adjacent rock is determined at intervals and plotted as a profile characteristic of the strata passed through. Very striking sets of profiles from groups of boreholes were shown, but caution was indicated since the results are affected by the methods of boring used, especially the nature of the mud; and the resistance of the rock itself may have widely differing values according to the presence of interstitial oil or saline waters.

To sum up: the meeting once again indicated the wide use now made of geophysical methods, and their acceptance in fact as one of the most important tools of geological research. The restrictions in their use are at present largely due to their relative novelty and rather high cost, which in Great Britain has tended to restrict their employment to commercial enterprise.

OBITUARIES

Captain John D. S. Pendlebury

CLASSICAL and prehistoric archæology suffer a severe loss in the death, during the invasion of Crete, of Captain John D. S. Pendlebury. He was the son of Herbert S. Pendlebury, a well-known London surgeon, and was educated at Winchester College and Pembroke College, Cambridge, where he held an exhibition and represented the University, and also England, in the high jump in 1926–27. As an undergraduate he showed already the high promise in classical scholarship and in archæology which he fulfilled in later years, and, on graduating in the first class of the Classical Tripos, he was awarded the School Studentship in the British School of Archæology at Athens (1927–28) followed by the Macmillan Studentship in 1928–29. He took part in excavations on prehistoric sites in Macedonia, and at Armant and Tell-el-Amarna in 1928 and 1929. This combination of Ægean and Oriental interests enabled him to put together in *Ægyptiaca* (1930) a 'corpus' of scarabs and other objects of Egyptian workmanship found on prehistoric sites in Greek lands, and he projected, with his scholarly and accomplished wife, a similar record of Ægean objects found in Egypt.

In 1930, Pendlebury was appointed curator of Knossos, in succession to Duncan Mackenzie, who had for many years been the principal assistant of Sir Arthur Evans. Here was a post which gave full scope to his abilities, for he was a persistent traveller and field-observer, and had the genial temperament which endeared him to all classes of Cretans. At Knossos itself there was still much to be done: supplementary excavation to clear up obscurities, reinforcement of repairs and precautions against weather damage to the 'Palace'; the preparation of a much-needed "Handbook to the Palace of Minos" (1933); and the classification, storage and calendaring of a very large accumulation of potsherds and other objects not needed by the Candia Museum, and indeed indispensable for minute study of the ruins. His intimate knowledge of the whole island found record in a larger handbook of the "Archæology of Crete" (1939).

It was part of the original arrangement that Pendlebury should continue during the winter months his direction of the Egypt Exploration Society's work at Tell-el-Amarna, but by 1934 the Egyptian and the Cretan duties had begun to conflict, and to the general regret Pendlebury resigned the curatorship of Knossos. For unforeseen reasons, however, the Egyptian work came to an end, and he found it possible to devote himself in his private capacity wholly to Cretan archæology. His memoir "City of Akhenaten II", published in 1933, gives a full account of his work in Egypt.

Thenceforward, with his wife, and a succession of younger students of the British School of Archæology, Pendlebury carried on minute and intensive exploration in the Lasithi highland, below the Dictæan Cave at Psychro, already excavated by the School; and the results of this have now appeared in a separate volume of the School's *Annual* (38, 1937–38) as well as current reports in earlier volumes; a remarkable record of the human occupation of this secluded region from the early Bronze Age until it became a refuge and last fortress of the Minoan people after the Iron Age invaders had conquered the lowlands of Crete.

When the War came, Pendlebury received a commission in a cavalry regiment but remained in Crete as British Vice-Consul and was able to render very valuable services through his intimate acquaintance with the country and the people. Rumours of his death during the German invasion remained long unconfirmed, but his death has now been presumed. He will be remembered as a man of varied ability, strong character and personal charm, and it is to be hoped that he may have left further memorial of his devoted study of Cretan antiquity.

John L. Myres.

We regret to announce the following deaths:

Prof. A. C. Davis, jun., head of the Department of Experimental Engineering at Sibley College, Cornell University, on March 17, aged fifty-two.

Prof. W. E. Davis, professor of plant physiology at the Kansas State College of Agriculture and Applied Science, on January 17, aged seventy-five.

Prof. R. W. Hegner, professor of protozoology in Johns Hopkins University, on March 11, aged sixty-two.

NEWS and VIEWS

King's Birthday Honours List

The following names of scientific men and others associated with scientific work appear in the King's Birthday Honours list:

O.M.: Prof. E. D. Adrian, professor of physiology in the University of Cambridge.

Baron: Mr. J. M. Keynes, the distinguished economist.

K.C.M.G.: Sir Guy Marshall, director of the Imperial Institute of Entomology.

K.B.E.: Dr. C. G. Darwin, director of the National Physical Laboratory.

Knights: Prof. R. H. Fowler, Plummer professor of mathematical physics in the University of Cambridge, lately liaison officer in North America; Dr. W. H. Fyfe, principal and vice-chancellor of the University of Aberdeen; Mr. H. Gaskell, a director of Imperial Chemical Industries, Ltd.; Mr. W. Gavin, chief agricultural adviser, Ministry of Agriculture; Mr. L. Mason, deputy director-general of supply, India, and lately inspector-general of forests; Prof. W. F. Shaw, president of the Royal College of Obstetricians and Gynæcologists; Major-General J. Taylor, I.M.S., director of the Central Research Institute, Kasauli; Mr. R. A. Watson Watt, scientific adviser on telecommunications, Ministry of Aircraft Production.

C.B.: Dr. H. J. Gough, deputy controller-general of research and development, Ministry of Supply.

C.M.G.: Prof. D. B. Blacklock, professor of tropical hygiene, University of Liverpool; Mr. G. F. Clay, director of agriculture, Uganda; Dr. A. F. Mahaffy, director of the Yellow Fever Research Institute, Uganda.

C.I.E.: Mr. W. T. Hall, chief conservator of forests, United Provinces; Mr. C. M. Harlow, chief conservator of forests, Central Provinces and Berar; Colonel E. A. Glennie, director of the Survey of India; Lieut.-Colonel G. R. McRobert, professor of medicine, Medical College, Madras; Dr. L. E. Napier, director of the School of Tropical Medicine, Calcutta; Lieut.-Colonel E. McK. Taylor, director of the Irrigation Research Institute, Punjab.

C.B.E.: Mr. G. E. Bodkin, director of agriculture and principal of the College of Agriculture, Mauritius; Dr. E. A. Carmichael, director of the Neurological Research Unit of the Medical Research Council, National Hospital for Nervous Diseases; Prof. T. J. Mackie, professor of bacteriology, University of Edinburgh; Mr. F. J. Mortimer, lately president of the Royal Photographic Society; Prof. A. C. Norman, director of the X-Ray Institute in Iraq and professor of radiology in the Royal College of Medicine, Baghdad; Dr. Z. F. Willis, general secretary of the Y.M.C.A.

O.B.E.: Mr. V. A. Beckley, senior agricultural chemist, Kenya; Mr. E. G. Bowen, senior scientific officer, Ministry of Aircraft Production; Dr. H. J. O'D. Burk-Gaffney, senior pathologist, Tanganyika; Mr. S. Butterworth, principal scientific officer, Admiralty; Mr. T. G. Henderson, principal veterinary officer, Basutoland; Mr. G. D. A. Macdougall, chief assistant, Statistical Branch, Prime Minister's Office; Mr. A. Monro, chief veterinary officer, Ministry of Agriculture; Dr. B. Prasad, director of the Zoological Survey of India; Mr. A. H. Stein, divisional forest officer, Hoshangabad, India; Mr. C. B. Symes, medical entomologist, Kenya; Mr. A. F. Thelwell, secretary of the Jamaica Agricultural Society; Mr. A. F. Wilkins, principal scientific officer, Ministry of Aircraft Production; Mr. H. Wooldridge, senior scientific officer, Department of Scientific and Industrial Research.

M.B.E.: Canon L. A. Lennon, for services to education and agriculture, in Nigeria; Mr. G. W. Lines, agricultural officer, Nigeria; Mr. R. E. Mills, technical assistant, Ministry of Aircraft Production; Mr. H. C. Mundell, agricultural and livestock officer, Basutoland; Miss K. M. Shaw, personal assistant to the Dean, London School of Hygiene and Tropical Medicine; Mr. L. B. Turner, deputy assistant director, Explosives Department, Ministry of Supply; Mr. J. J. Unwin, scientific officer, Ministry of Aircraft Production.

I.S.O.: Mr. G. D. Goode, chief clerk, Department of Science and Agriculture, and personal secretary to the Director of Agriculture, Jamaica.

Prof. E. D. Adrian, O.M., F.R.S.

The recognition of the value of the work of Prof. E. D. Adrian to science by the award of the Order of Merit will be a source of great pleasure to his colleagues and students throughout the world. The advance in our knowledge of the working of the nervous system that has taken place in the last twenty years owes much to his long series of researches into the nature of the fundamental processes in nerve cells. As research in clinical neurology is able to make full use of this knowledge, further advances may also spring from his work, but this application must, of necessity, take a long time to reach fruition. Prof. Adrian's work on nerve and muscle, in association with Keith Lucas, started before the War of 1914–18; during that War he worked in clinical neurology, which gave him a wide experience and interest in neurology as well as electrophysiology. During the War of 1914–18 Keith Lucas and Adrian had discussed the new possibilities opened up by the thermionic valve, of investigating the electrical activity of the nervous system in detail. After Lucas's death, Adrian succeeded in realizing these possibilities, and in 1924 started the series of researches on the activity of single nerve fibres which in the next ten years were to yield such a rich harvest of new knowledge of the action of the sense organs and of reflex activity. As technical advances became possible these were adopted to refine the method, and his laboratory became the centre of research in electrophysiology to which research workers went from all over the world to learn these methods. The focus of work gradually moved from the investigation of the electrical activity of peripheral nerve fibres to that of nerve cells and synaptic regions of the central nervous system.

The spread of interest in brain potentials in man is largely due to Adrian's work in this field; the implications of the discoveries in this field by Hans Berger were not generally realized and the discoveries lay dormant for ten years until Adrian reinvestigated them, confirmed and extended Berger's work, and linked up his findings with general knowledge of the nervous system by animal experiments. Adrian's main interest has always been to discover the principles underlying all nervous structures as these apply throughout the animal kingdom, and the application of these to the nervous system of man. Thus his work on the electrical activity of the nerve ganglion of the water beetle assisted him in interpreting brain potentials in man; again, experiments on single motor nerve fibres in cats led to the investigation of voluntary control of human muscles in intact man by needle electrodes, and this method has become a valuable tool to the neurologist in investigating the nature of nervous diseases. Adrian's work owes much to his manual dexterity; he carries out all details of experiments himself and constructs much of his own apparatus. He encourages his students to work in the same way to the surprise of some visitors who expect to find a large staff of technical assistants. The success of this policy of close contact with experimental material is attested by the large volume of research carried out by students in his laboratory, and by schools founded abroad by physiologists trained in electrophysiological research in Cambridge. Since Prof. Adrian's work on individual nerve cells has been complementary to the researches of the Sherrington School on reflex action and the behaviour of large numbers of neurones, it is fitting that he should join Sir Charles Sherrington in the select company of those who have received the Order of Merit.

Science and Engineering in China

IN a review of developments in China under the republican regime entitled "China To-day: The Thirtieth Anniversary of the Chinese Republic, 1911–1941" (Central Union of Chinese Students in Great Britain and Northern Ireland, Sidney Sussex College, Cambridge. Pp. 55. 1*s*.) there are three articles of special interest to scientific workers. The first of these, by P. M. Yap, describes the utilization of science in China, where science and statecraft are already closely linked. In peace-time, the National Economic Council is responsible for economic planning, the execution of its plans resting with the Ministries of Economic Affairs, Agriculture and Forestry, and Communications. The former maintains three research institutes for hydraulic engineering, for mining and metallurgy, and for industrial technology. Under the Ministry of Agriculture there is the National Agricultural Research Institute, and various research bureaux are attached to the Ministry of Communications, and also directly to the National Economic Council. The National Health Administration has steadily established a series of public health stations and clinics all over the country and has contributed much to the expansion and improvement of the Army Medical Service. Most of its research and development work is carried out in the National Institute of Health. Apart from the universities and private research foundations, scientific research of the long-range type is carried out by the Academia Sinica and the National Academy at Peiping, the former of which, through the National Research Council, is responsible for directing and co-ordinating scientific activities in China.

The difficulties which face the development of the medical profession in China are outlined in an article "Unburied Ghosts", which indicates that traditional knowledge and forms of medical practice are likely to be detrimental to the progress of medical science, particularly in view of the low proportion of medical students with a scientific outlook. A brighter picture is given by T. C. Chan in his article "Review of Chinese Engineering". Despite the persistent opposition of Japan, particularly her destruction of Chinese engineering institutes by air attack, a vigorous engineering policy has been executed. During the second stage of the War, 386 factories were transplanted into the interior, while a further 1,378 factories have been recently established in eleven industrial centres all over free China, to increase production for military and non-military needs. At the end of 1940, the number of higher educational institutions, including universities and technical colleges, was 113, as against 108 before the War. Engineering works for communication and transport have been in full swing since 1937, and once peace is restored Mr. Chan considers that the effective development of Chinese industries will open up a new era for the engineering world.

The Royal Institution

THE managers of the Royal Institution have made special arrangements for carrying on the work of the Institution under the present conditions. Activities are necessarily somewhat limited by war circumstances, and many members of the staff of the Institution itself and of the Davy Faraday Research Laboratory are absent on war service. The laboratories and workshops are, however, fully employed, and a programme of lectures has been successfully carried out during the 1941–42 season. The Institution has also, with the managers' permission, been the centre for various scientific meetings and conferences in connexion with war purposes; among them, a course of special lectures, in November and December 1939, to meet the needs of students wishing to qualify for radio branches of the Defence Forces; a series of lectures on "The Nation's Larder", in April and May 1940, arranged with the approval and support of the Ministry of Food; and in September 1941, the Conference on Science and World Order, held by the Division for the Social and International Relations of Science of the British Association. It is hoped to maintain and perhaps extend the activities.

As a temporary measure, pending the appointment of a successor to Sir William Bragg, the managers have made the following appointments: The general secretary, Mr. Thomas Martin, on leave of absence with the Ministry of Supply, to be 'resident' in charge of the house; Mr. R. Cory, librarian, to be deputy general secretary; Dr. A. Muller, assistant director of the Davy Faraday Research Laboratory, to be acting director.

American Philosophical Society Research Grants

THE Yearbook of the American Philosophical Society, 1940, covers the year January 1–December 31, 1940, and in addition to the minutes of the executive sessions includes the reports of standing committees as well as of the Special Committee on Education and Participation in Science, the purposes of which are to conduct a survey of amateur science in the Philadelphia area and to stimulate participation of laymen in scientific research. Almost half the volume is occupied by the report of the Standing Committee on Research, which includes reports from recipients of grants from the Penrose Fund, from which 107 grants, totalling some 360,750 dollars, were awarded during the year. Of these, two were in mathematics, five in astronomy and astrophysics, seven in physics and eleven in chemistry and geochemistry. Eight grants were made in zoology, four in genetics and cytology, nine in botany, eight in physiology, one in biochemistry, four in pathology and medicine, ten in American and modern history, one in political science, four in archæology, and four in ethnology. The distribution is roughly proportional to the number of applications from the different classes, and the Committee on Research has always attempted to make the grants to the most worthy applicants without reference to the subjects represented. Further, since the funds at the disposal of the Committee are insufficient to make long-continuing grants, the policy has been to help start or finish worthy projects rather than to furnish continuing support, nor have grants been made to pay in whole or part the salaries of members of the staff of any institution, nor in general to pay living expenses of applicants.

New Exchange-Area Cable

AN article by N. V. Firth (*Bell Lab. Rec.*, 20, No. 8; April, 1942) describes an investigation carried out to determine whether the most economical series of new telephone cables would result from reductions in the diameters of cables having 24- and 26-gauge conductors, together with the addition of a cable with conductors of a smaller size such as 28-gauge, or whether the 24- and 26-gauge should be superseded by 25- and 27-gauge. Experimental lengths of cable were manufactured with conductors of each of these sizes, all with reduced amounts of pulp insulation. Studies of dielectric strength were made on each type. Thickness of pulp insulations used for full-sized cables containing 1,515 pairs of 24-gauge, 1,818 pairs of 25-gauge, 2,121 pairs of 26-gauge, 2,424 pairs of 27-gauge, or 3,030 pairs of 28-gauge provide satisfactory dielectric strength. No major alterations in the cable manufacturing equipment would be required for the introduction of any of these new types. A study of overall savings indicated that the greatest advantage would result by retaining the four existing standard gauge sizes and increasing the maximum number of pairs in 24-gauge and 26-gauge cables to 1,515 and 2,121 pairs respectively. Thinner insulations of the new cables have somewhat lower dielectric strengths than those of the previously standard 24- and 26-gauge pulp-insulated cables. Tests indicate, however, that they are at least as good as the corresponding strip-insulated 24- and 26-gauge cables which form a large part of the existing plant.

For assembling the required number of 24- or 26-gauge pairs into cables the method is the same as that for the previously standard 24- or 26-gauge designs. Cables ranging in sizes from 11 pairs to 101 pairs are stranded as a single unit. Those larger than 101 pairs and up to 303 pairs are first built up in small units of 50 or 51 pairs which are then assembled in long spirals to form the completed cable. All sizes larger than 303 pairs are formed similarly from units of 101 pairs each. The colour code for the groupings of pairs remains the same in the new designs as in other unit type cable in recent years. The larger number of pairs obtainable in the full sizes of these new designs will in some instances prove economical in plant rearrangements incident to central-office cutovers and should be advantageous in making additions to plant where there is underground conduit congestion. The major savings, however, are expected from the reductions in sheath diameters for cables of the same numbers of pairs as formerly.

Earthquake Recorded at Kew

THE strong earthquake of May 14 in Ecuador (NATURE, May 23, p. 578, and May 30, p. 607) was recorded at Kew Observatory, *iP* appearing on all components of the seismograph at 02h. 25m. 51s. U.T. This was compressional. A full suite of pulses followed and the shock finished recording at about 07h. 45m. U.T. The estimated epicentral distance was 9,520 km. All interpretations are tentative.

Announcements

MR. WILLIAM MORRISH SELVEY is to continue for another year as president of the Institute of Fuel. Mr. Selvey, who has been connected with the Institute since its inception, and has for several years been chairman of the Council, took office as president in October 1941.

THE following appointments and promotions in the Colonial Service have recently been made: H. D. Jordan, agricultural officer, Sierra Leone; A. G. Beattie (assistant director of agriculture), deputy director of agriculture, Nigeria; L. D. Cleare (entomologist), deputy director of agriculture, British Guiana; R. M. Davies (senior agricultural officer, Tanganyika Territory), senior agricultural officer, Zanzibar; I. E. James (principal agricultural officer), assistant director of agriculture, Nigeria; D. H. Urquhart (senior agricultural officer), principal agricultural officer, Nigeria.

MR. T. SHEPPARD has produced an important catalogue of the Bronze Age implements in the Mortimer Museum, Hull (*Hull Museum Pub.*, No. 213). There are a number of illustrations. Hull has been fortunate in the past in the matter of acquisitions and its Bronze Age collections are important. Prehistorians, therefore, will be grateful for this new catalogue.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Origin of the Solar System

THE tidal theory of the origin of the solar system which I proposed in 1916 supposed that when the planets were born, the sun was comparable in size with the present planetary orbits. Recent workers at the subject have, however, supposed that the sun was of about its present size.

Yet on any reasonable view of stellar evolution, there must have been a time in the past when the sun, then rapidly contracting, extended to thousands of times its present radius. If, for simplicity, we imagine an epoch in which sun and stars all had precisely n times their present radii, the chance (per unit time) of planets being generated by a tidal encounter of the type contemplated by my theory would be n^2 times as great as now. For example, when the sun extended as a semi-nebulous mass to the orbit of Uranus, the chances would be 17,000,000 times as great as now: more planetary systems would be born in 120 years then than in 2,000 million years of present conditions.

Let A denote the chance (per unit time) of planets being born out of our sun under present conditions, this being of the order of $(5 \times 10^{18}\ \text{years})^{-1}$. Then the total chance of planets having been born in the whole period since the sun was of N times its present radius is

$$A \int n^2\,dt = -A \int_1^N \frac{n^2\,dn}{dn/dt}.$$

In its earliest stages, in which n was large, the sun was probably engaged in a rapid Helmholtz contraction, having no sources of energy beyond its own gravitation. Assuming Lane's law to hold, the rate of solar radiation would be C/n^2, where C is the present rate, and the exhaustion of the sun's energy would be G/n, where G is the present exhaustion. Equating C/n^2 to the rate of increase of G/n, we find that $-dn/dt$ has the constant value C/G. This is about $(2 \times 10^7\ \text{years})^{-1}$, since G/C is the time through which the sun could have radiated at its present rate on the Helmholtz theory of gravitational contraction, that is, Kelvin's estimate of the maximum age of the earth.

If we replace $-dn/dt$ by C/G, the above integral assumes the value $\frac{AG}{3C} N^3$, or about $10^{-12}N^3$. The true value must be greater than this, since every additional source of energy retards contraction, and so decreases the value of $-dn/dt$. But it will not be much greater, since nearly all the value of the integral comes from large values of n, for which our approximation is good; the contribution from values of n near to unity, where our approximation fails through other sources of energy being operative, is quite insignificant.

If we take N equal to 5,000, we start from a sun which is big enough to include the orbit of Uranus, and yet is not too diffuse to hang together dynamically, and find that the planets are most likely to have been formed before n fell much below 4,000. With such values for n, we escape the very serious dynamical difficulties which result from supposing that the sun was of its present size when the planets were born. Moreover, the integral gives the total chance of planets being born as 1 in 6, whereas the chance of a sun of the present size producing planets in 2,000 million years is only about 1 in 2,500,000,000. Thus there is no longer any need to strain the probabilities to account for the existence of the planets.

The average mass of planets born by gravitational instability out of a gaseous filament varies as $T^{\frac{3}{2}}\rho^{-\frac{1}{2}}$ and if we again assume Lane's law this remains constant through the contraction. The minimum mass which can hold together gravitationally, without scattering into space, also varies as $T^{\frac{3}{2}}\rho^{-\frac{1}{2}}$, so that this again remains constant. Thus the values of these two quantities will not be affected by an increase in the value of n.

The foregoing rough calculations obviously call for many adjustments: for example, Lane's law cannot be expected to give accurate results for a star of 5,000 times the diameter of the sun. But most of the adjustments will, I think, be found to strengthen, rather than weaken, the case I have been putting and, even if some do not, there is an ample margin to spare. Thus I suggest, although very tentatively, that:

(1) Of the various planetary systems in the sky, the vast majority were formed while their suns were still in a semi-nebulous state.

(2) The supposition that our own system was formed while the sun was still a semi-nebulous mass, of hundreds or perhaps thousands of times its present diameter, avoids most—perhaps all—of the dynamical objections which have recently been urged against the tidal theory.

(3) A far larger proportion of the stars than we have hitherto imagined must be accompanied by planets; life may be incomparably more abundant in the universe than we have thought.

J. H. JEANS.

Park House,
Wanstrow,
Somerset.
May 30.

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[1] *Mem. Roy. Ast. Soc.* (1916).

The Amphibian Pituitary

IN a recent paper[1] Atwell reports an examination of the pituitary complex of *Xenopus lævis*, and concludes the discussion with the assertion that this species "does not afford unique morphological opportunities for determining the function of the *pars tuberalis*". So stated, this controverts earlier views expressed by Hogben and Slome[2,3]; but a lengthy addendum printed after it shows that Atwell's findings are not necessarily in opposition to views expressed by workers in my laboratory. What difference of opinion exists seems to be a semantic rather than a factual issue. There is no disagreement concerning the following facts:

(*a*) The anterior lobe of Xenopus has a prominent median 'anterior process' made up of basophil cells.

(*b*) The pituitary of Rana has no such process; but a corresponding vestigial structure may be present in toads (Arcifera).

(*c*) The pars tuberalis of Bufo is represented by a pair of glandular discs lying on the infundibulum, detached in the process of development from the two extremities of a bifid outgrowth in much the same position as the anterior process of Xenopus.

Atwell now contributes the additional information that there are comparable discs on the infundibulum of Xenopus but concedes: (*a*) they are "composed of small cells which give slight indication of glandular capacities"; (*b*) "it is not surprising that (*they*) have been overlooked by other observers". It is not clear what the epithet "slight" signifies in this context. From my own experience at the time when I first examined the pituitary of Xenopus I can confirm the existence of these discs; and am not disposed to dispute their *structural* homology with the paired glandular lobes of Firmisternia. I rejected, and still reject, the propriety of regarding them as *functionally* equivalent to the latter because indications of their glandular activity are at most as slight as stated above.

If they are not functionally active, the validity of the view under discussion turns on whether the anterior process of Xenopus corresponds to the base of the embryonic tuberalis of other Anura at the time of metamorphosis. In the text which precedes the postscript mentioned, Atwell casts doubt on this. He states: "whether the anterior process represents the region of earlier attachment of the pars tuberalis, and whether it is histologically related to the pars tuberalis are unknown". The addendum which follows the discussion deals with the development of the pituitary complex of *Bufo boreas boreas*, a species with a detached anterior process of variable size. Atwell there describes its origin as follows: "The lateral lobes which are destined to form the pars tuberalis are still attached to the anterior lobe by a single median stalk . . . there is a constriction between the anterior lobe and the single stem of the Y. . . . If this constricting process should continue to the point of complete separation and the lateral lobes should become detached (as apparently they always do) to form the two plates of the pars tuberalis, then this central mass of cells would be left isolated on the surface of the median eminence. . . . It seems justifiable to conclude that the anterior process of the hypophysis of *B. boreas boreas* is a rudimentary structure probably derived from the median stalk which served to attach the embryonic pars tuberalis to the anterior lobe."

My original reason (see ref. 3, p. 168) for regarding the anterior process of Xenopus as the functional equivalent of the paired pars tuberalis of other Anura was based on Atwell's earlier description of the development of *Bufo americana*[4]. This species also has a *Y*-shaped extension at the time of metamorphosis. Atwell now appears to agree: (*a*) that the anterior process of Xenopus is equivalent to the anterior process of *B. boreas boreas*; (*b*) that the anterior process of the latter is the persistent median portion of the *Y*-shaped extension of the embryonic pars anterior. Thus the only matter about which there is difference of opinion is whether we are entitled to apply the term pars tuberalis: (*a*) to derivatives of the *whole* embryonic structure including the persistent median portion which apparently persists as a prominent glandular lobe in Xenopus and disappears in Rana; (*b*) *only* to the remains of the lateral limbs which persist in all Anura but merely as vestigial organs in Xenopus. I am still inclined to regard the former as more reasonable. Either way, the pituitary of Xenopus offers unique opportunities for studying the physiological properties of histologically differentiated components of the pituitary complex.

LANCELOT HOGBEN.

Department of Zoology,
University of Birmingham.
May 21.

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[1] Atwell, *Amer. J. Anat.*, **68**, 191 (1941).

[2] Hogben and Slome, *Proc. Roy. Soc.*, B, **108**, 10 (1931).

[3] Hogben and Slome, *Proc. Roy. Soc.*, B, **120**, 158 (1936).

[4] Atwell, *Anat. Rec.*, **15**, 73 (1918).

Microbiological Assay of Riboflavin in Cereals

THE assay of riboflavin in cereals by fluorometric methods[1,2] is difficult and the results are of doubtful reliability. One difficulty is the low riboflavin content of cereals. There is also the possibility of the presence of interfering substances in cereal extracts. On the other hand, the microbiological method of Snell and Strong[3], using *Lactobacillus helveticus*, with certain modifications, has proved to be satisfactory and expeditious.

The work described below will be published later in detail, but the chief modifications that have been introduced are the addition of xylose, asparagine, nicotinic and pantothenic acids to Snell and Strong's original medium, and the method of preparing the extract. The actual estimation was carried out by measuring the turbidity of the solutions nephelometrically or by titrating the amount of lactic acid formed by the bacteria with 0·1 *N* NaOH. The results from either of these methods of estimation are in good agreement.

It has been shown[4] that starch has a marked effect in stimulating the growth of *L. helveticus*, and as cereals contain a large amount of starch, this must be destroyed in the extract before the estimation is carried out. Scott *et al.* recommend taka-diastase for this purpose. In the present investigation it was found, however, that taka-diastase was unsatisfactory. The various samples of the enzyme used showed a marked stimulating activity over other hydrolysing agents, such as ptyalin, sulphuric and hydrochloric acid. The method of extraction that was eventually adopted was to hydrolyse suitable weighed samples of material with 0·25*N* HCl for 15 minutes at 15 lb. pressure in an autoclave. Nevertheless, hydrolysis with ptyalin in place of taka-diastase[4] or refluxing for one hour with 0·25*N* sulphuric acid[1] or 0·25*N* hydrochloric acid were all found to give the same results as autoclaving for 15 minutes. Autoclaving of the material was adopted simply because it was found to be more convenient.

Results from the different methods of extraction are given below:

	Sample	Riboflavin content γ/gm.
	National straight run flour (75 per cent extraction)	
1.	Hydrolysed with ptyalin	0·75
2.	Refluxed with 0·25*N* H_2SO_4 for 1 hour	0·75
3.	,, ,, ,, HCl ,, ,, ,,	0·8
4.	Autoclaved at 15 lb. pressure for 15 min. with 0·25*N* HCl	0·8
5.	Hydrolysed with taka-diastase	1·15

The results of a number of determinations on different varieties of wheat, various fractions of the wheat grain, wheaten flours, as well as other cereals are given in the accompanying table: figures are

	Sample	Riboflavin content γ/gm.
1.	Wheat, English	2·65
2.	,, Manitoba	2·9
3.	,, Australian	2·65
4.	,, Russian	3·7
5.	,, Testa	5·8
6.	,, Aleurone layer	6·3
7.	,, Germ, commercial sample (1)	11·35
8.	,, ,, ,, ,, (2)	12·85
9.	,, ,, ,, ,, (3)	9·7
10.	Flour A roll	0·4–0·5
11.	,, C ,,	0·5–0·6
12.	,, National straight run (75 per cent extraction)	0·75–1·25
13.	,, National wheatmeal (85 per cent extraction)	2·0–2·1
14.	Barley	2·3
15.	Rye	2·65

based on the normal water contents of the products.

Since this work was completed, Andrews, Boyd and Terry[5] have published results for the riboflavin content of different cereals, using apparently the original Snell and Strong procedure, but no details of the medium are given. With the exception of patent flour, their results are all much lower than those now reported. One explanation for these low figures is that their extracts were too concentrated (5–10 gm. made up to 100 ml.). In my experience there is always a falling off in estimated riboflavin content if the extract is too concentrated. The extracts used in the present investigation were always made up to 500 ml., and in some cases, for example, germ, to 1,000 ml.

It is of interest to note that Miss Copping[6] (see also in this connexion Bacharach[7]), using a biological method, obtained values of the order of 2–3 γ per gram for a National wheatmeal, or of the same order as those reported here. A further proof that the microbiological method is specific is shown by the fact that for milk the values obtained by me (1·4–1·5 γ/ml.) are practically identical with those obtained by the fluorometric method[7].

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May 29.

[1] Hodson, A. Z., and Norris, L. C., *J. Biol. Chem.*, **131**, 621 (1939).

[2] Najjar, V. A., *J. Biol. Chem.*, **141**, 355 (1941).

[3] Snell, E. E., and Strong, F. M., *Ind. Eng. Chem.* (Analytical Edit.), **11**, 346 (1941).

[4] Scott, M. L., Randall, F. E., and Hessel, F. H., *J. Biol. Chem.*, **141**, 325 (1941).

[5] Andrews, J. S., Boyd, H. M., and Terry, D. E., *Cereal Chem.*, **19**, 55 (1942).

[6] Copping, A. M., *Chemistry and Industry*, **60**, 723 (1941).

[7] Bacharach, A. L., *Chemistry and Industry*, **60**, 791 (1941).

[8] Kon, S. K., Nature, **148**, 607 (1941).

Disappearance of the Ascorbic Acid in Raw Cabbage after Mincing or Chopping

Pyke[1] has lately stated that when raw savoy cabbage was shredded by means of household shredders part of the ascorbic acid disappeared during the ensuing 5–10 minutes and thereafter no further loss occurred during three hours standing; the extent of the initial loss of ascorbic acid varied with the type of shredder used. His explanation is that the initial loss of ascorbic acid is essentially due to the mechanical rupture of the cells, and will therefore vary with differing types of shredder or grinder.

As mentioned previously[2], we have been working on similar lines and have sought to find a correlation between mechanical breakage of cells and loss of ascorbic acid. It would appear that the amount of liquid which can be squeezed from shredded cabbage would be indicative of the breakdown of cell tissue, and we have proceeded on this line of attack. *Inter alia* we have confirmed Pyke's results.

In Fig. 1 the concentration of ascorbic acid in minced cabbage, expressed as a percentage of that originally present, is plotted against the time of standing after mincing. The curves show that the concentration of ascorbic acid falls rapidly during the first 10–15 minutes. The steady value reached remains constant for periods up to thirty hours (provided that the cabbage be kept cool, at, say, 15° C.). The extent of the initial loss of ascorbic acid varies with the type of mincer used.

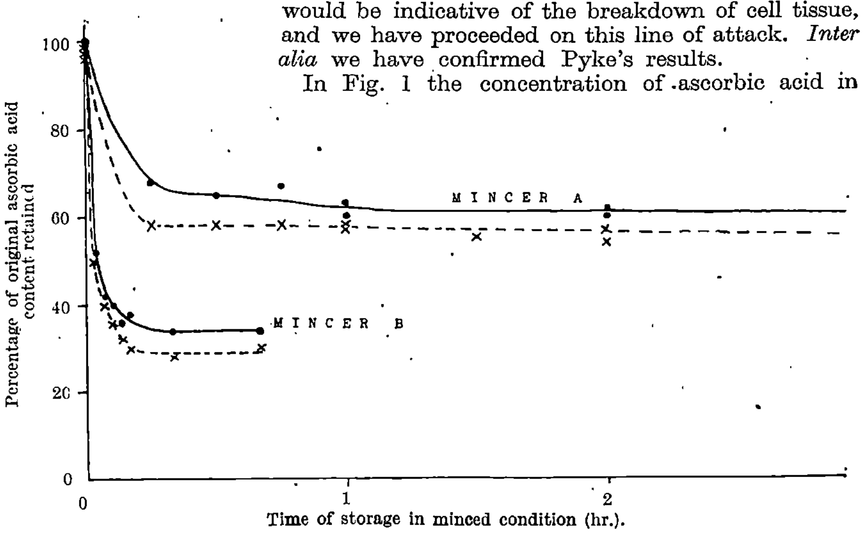

Fig. 1.

●——● total ascorbic acid; x – – – – – x, reduced ascorbic acid.

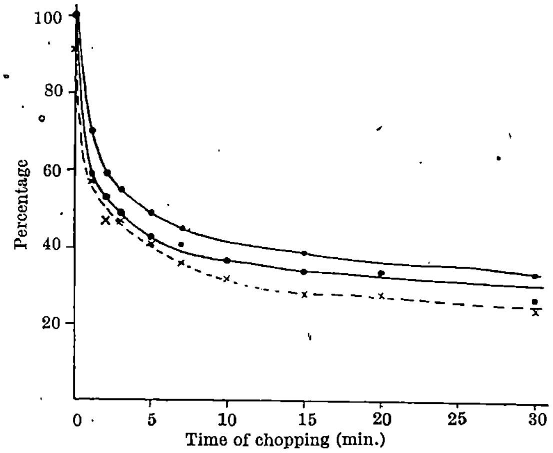

Fig. 2.

●——●, total ascorbic acid. x – – – – x, reduced ascorbic acid.

Uppermost curve, percentage of residue from pressing; other two curves, percentage of original ascorbic acid retained.

All samples allowed to stand for 2 hr. after chopping.

Some confirmation of the theory that the extent of initial loss varies with the extent of rupture of cells has been obtained by chopping cabbage in a machine primarily used for chopping sausage mixes. The material to be chopped is placed in a bowl which revolves beneath a set of rotating knives; for short periods of chopping the degree of comminution obtained is considered to be roughly proportional to the time of chopping. Samples were withdrawn at intervals and allowed to stand. The concentration of ascorbic acid was determined in these samples after two hours, when a steady state had been reached, and again after twenty-two hours. At the same time the amount of juice which could be pressed from each sample under certain conditions was determined. The results are plotted in Figs. 2 and 3 and indicate that the longer the time of chopping the greater the percentage of ascorbic acid lost and the greater the amount of juice which may be obtained by pressing. In Fig. 2 the correspondence between the curves for the percentage of ascorbic acid lost and the percentage of residual material after pressing may be fortuitous.

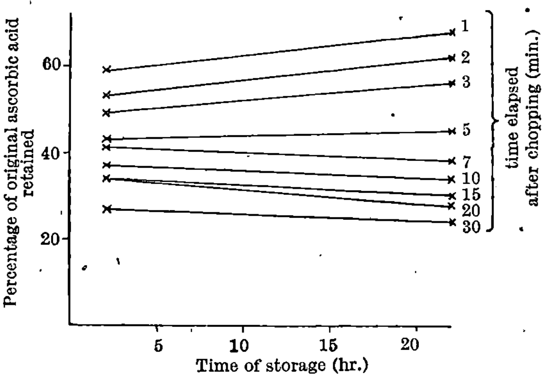

Fig. 3.

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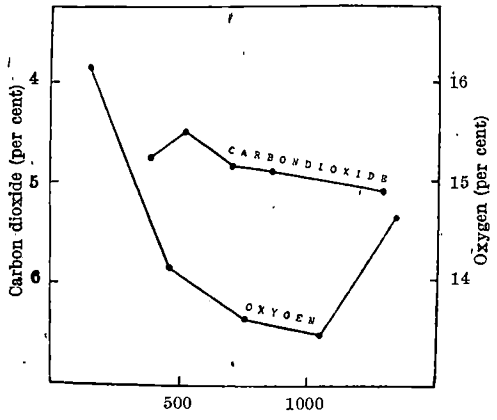
June 3.

[1] NATURE, 149, 499 (1942).

[2] NATURE, 149, 271 (1942).

The 'Oxygen Trough' of Expiration

I have been unable to confirm[1] the presence of an alveolar air plateau as described by Haldane[2]. Two of the subjects investigated gave paradoxical results in that the ultimate alveolar sample had a lower carbon dioxide tension than the penultimate. In a paper presented at the same time, Cotton[3] examined the oxygen percentages, and demonstrated what he later described as the "oxygen trough of expiration". His oxygen figures were in harmony with my results; that is, the percentage of oxygen of the ultimate sample was higher than that of the penultimate.



The oxygen results from one of the subjects used by me are given in the accompanying graph. They confirm the findings of Cotton.

No satisfactory explanation of this phenomenon, which has recently been confirmed by Marenzi and Costoya[4], is at present available. It seems reasonable to assume that it is due to inequality of ventilation, or inequality of the blood-flow to the different parts of the lung.

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Manchester, 13.
May 4.

[1] Mackay, I. F. S., *J. Physiol.*, 98, 73 (1940).

[2] Haldane, J. S., and Priestley, J. G., "Respiration", 20 (1935).

[3] Cotton, F. S., *Austral. J. Exp. Biol.*, 17, 433 (1939).

[4] Marenzi, A. D., and Costoya, M. A., *Rev. Soc. Argent. Biol.*, 17, 190 (1941).

Crystal Dynamics of Rocksalt

THE early X-ray experiments of James, Firth and Waller[1] on the modification of the diffracting power of crystals of sodium chloride due to thermal vibrations of the atoms dealt only with the reduction in intensity of the Bragg reflexions at different temperatures, and could therefore only give average root mean square amplitudes, but the more recent diffuse spot methods promise to give information concerning the whole frequency spectrum. By observation of the position, shape and intensity of the diffuse spots when the crystal is turned into a succession of reflecting positions, the effect of vibrations travelling in different directions, polarized in definite ways and with frequencies within known limits, can be traced[2,3,4].

The above interpretation of the diffuse spot photographs has, however, been challenged by Sir C. V. Raman[5], and one of his colleagues, Dr. C. S. Venkateswaran[6], has published experimental results for sodium chloride crystals which are claimed to be inconsistent with the thermal (Faxén-Waller) theory. Since the challenge includes a denial of the validity of the Born theory of lattice dynamics, it is important that the experimental evidence should be carefully examined.

Venkateswaran's observations are as follows: (1) variation of diffuse spot intensity with temperature (one crystal setting, three temperatures); (2) comparison of diffuse spot and Laue spot intensities for three different irradiated volumes of crystal, using a slightly divergent beam; (3) measurements of relative sharpness; and (4) intensity, of 200, 400, 600 reflexions (molybdenum unfiltered radiation, one crystal setting); (5) comparison of 111, 222 reflexions; (6) measurement of the 'drift' of the diffuse maxima towards the Laue spots as the crystal rotates.

Every one of these experimental observations is either inaccurately performed or wrongly interpreted. The main criticisms are as follows:

(1) Venkateswaran has neglected the falling off of

atomic scattering power with temperature, an important effect which would reduce his deduced 'X-ray active' frequency from 160 cm.$^{-1}$ (his figure) to 100 cm.$^{-1}$. The latter does not correspond to a Raman frequency, and is in fact altogether below the range of optical frequencies for NaCl. It corresponds to an angular frequency $1{\cdot}89 \times 10^{13}$, but no reliance can be placed even upon this figure (although it would agree well with the thermal theory), since the intensity measurements are obviously extremely rough and limited in extent.

(2) He assumes that Laue spot and thermal spot intensities should vary differently with crystal volume. This is not the case; both are proportional to the crystal volume, proper experimental precautions being taken and corrections made[7]. Venkateswaran has compared diffuse spots given by $\lambda = 0{\cdot}710$ with Laue spots due to $\lambda = 0{\cdot}417$, $0{\cdot}592$ and $0{\cdot}401$ A., using a thick crystal for which no differential absorption corrections are made. He states that there is no variation of the Laue/diffuse spot intensities, as indeed the thermal theory predicts, but his photographs cannot be accepted as serious evidence either way.

(3) He assumes that the velocities of elastic vibrations are identical in all directions and irrespective of polarization (Raman also states that such a simplified treatment "should be a fair approximation to the truth"; *ibid.*, p. 344). A recognition that this is far from being true is vital to a proper comparison of theory and experiment. Venkateswaran's measurements of sharpness, etc., are in reasonable agreement with the correct version of the thermal theory, though not with the approximate theory that he assumes.

(4) His assumption that the thermal theory predicts the same law of intensity decay with angle of diffraction for diffuse as for Bragg reflexions is incorrect. Temporary displacements of atoms naturally affect the small-spacing and high-order reflexions much more than those of large spacing or low order. This was well confirmed by Laval's careful observations[8]. He found for potassium chloride at 290° C., using molybdenum $K\alpha$ monochromatized radiation and measuring the diffuse spot intensities (by the ionization spectrometer) at a constant angular displacement from the Bragg reflecting positions:

	002	004	006	008	0010
Bragg intensity	100	20	7	3	1
Diffuse intensity	100	50	33	21	12

For planes of similar structure factor but different force constants the diffuse spot intensities may bear little relationship to the Bragg intensities. This was also confirmed by Laval.

(5) It follows from (4) that Venkateswaran was wrong in expecting that, according to the thermal theory, the 111 : 222 diffuse spot intensity ratio would be equal to that of the Bragg spots. Moreover, the method he used of obtaining the diffuse reflexions by transmission through a thick crystal of an "effective X-ray wave-length maximum" of 0·46 A. was quite unsuitable for comparison of intensities. In fact, Fig. 3 (plate 29) of his paper shows that some molybdenum characteristic radiation was also being transmitted, and this would certainly invalidate his measurements. Accurate intensity comparisons are only possible using monochromatic radiation, proper allowance being made for 'unwanted' components.

(6) In order to explain the drift of the diffuse maxima towards the Laue spots, Venkateswaran postulates 'phase-waves' parallel to certain of the {311} planes. This drift is a natural consequence of the thermal theory, which predicts its magnitude and direction correctly[9] and without any extraneous assumptions.

I do not suggest that the thermal theory has reached a state of perfection and is now beyond criticism. That is not the case. It may, however, be claimed that the experiments described by Venkateswaran, in so far as the results are of value, confirm and do not contradict the thermal theory. From this point of view, therefore, there is no ground for criticism of the Born lattice theory.

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[1] James R. W., *Phil. Mag.*, **49**, 585 (1925); *Manchester Memoirs*, **71**, No. 2 (1926–27); James, R. W., and Firth, E. M., *Proc. Roy. Soc.*, A, **117**, 64 (1928); Waller, I., and James, R. W., *Proc. Roy. Soc.*, A, **117**, 214 (1928).

[2] Zachariasen, W. H., *Phys. Rev.*, **59**, 860 (1941).

[3] Jahn, H. A., *Proc. Roy. Soc.*, A, **179**, 320 (1942).

[4] Lonsdale, K., and Smith, H., NATURE, **148**, 628 (1941); **149**, 21 (1942). Lonsdale, K., *Proc. Phys. Soc.* (in the press).

[5] Raman, Sir C. V., *Proc. Ind. Acad. Sci.*, A, **14**, 317, 332 (1941).

[6] Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, A, **14**, 387, 395, 426 (1941).

[7] Robinson, B. W., *Proc. Roy. Soc.*, A, **142**, 431 (1933).

[8] Laval, J., *Bull. Soc. Franç. Min.*, **62**, 137 (1939).

[9] Jauncey, G. E. M., Baltzer, O. J., and Miller, D. C., *Phys. Rev.*, **59**, 908 (1941). Zachariasen, W. H., *Phys. Rev.*, **59**, 909 (1941). Baltzer, O. J., *Phys. Rev.*, **60**, 460 (1941).

Regulation of Experiments on Living Animals

At the end of June a somewhat rare event will take place. The Home Office will make an appointment under the Cruelty to Animals Act, 1876, which regulates the practice of experiments on living animals.

An inspector under the Act exercises an important function, not, indeed, as a policeman, but in advising research workers as to the interpretation of their obligations in particular cases. In view of the number of experiments licensed under the Act, direct supervision is not practicable on any material scale, but I assume that the majority of research workers do not desire to contravene the regulations, and that the inspector's guidance will in general be effective.

The Act lays down a compromise between the claims of science, on one hand, and the rights of animals, on the other; the line drawn in the practical application of the compromise must inevitably be an arbitrary one. Until somebody can lay down clear-cut rules which will command general assent, the best that can be done is to make as fair a compromise as possible. This calls for exceptional impartiality, and since a man with the indispensable scientific training will necessarily have a predisposition in favour of science, it is important that he shall also have an offsetting predisposition in favour of the other party in the compromise. This could be ensured by requiring candidates for the post to prove that they have in the past been effectively associated with some effort to better man's treatment of animals, wild or domestic. Preferably they should also have veterinary knowledge.

P. CHALMERS MITCHELL
(President).

Universities Federation for Animal Welfare,
at 284 Regent's Park Road,
London, N.3.

RESEARCH ITEMS

Fishes from the Philippines

Bulletin, **13**, 100, of the United States National Museum (1941), is the sixth volume of Henry W. Fowler's studies of the fishes collected by the United States Bureau of Fisheries steamer *Albatross* in the Philippines. This is mainly on the primitive fishes, following through the various groups of living forms to the more generalized bony types. The greater part deals with the sharks, rays and chimæras, but among the bony fishes clupeoids, catfishes and carp are included. It is a handsome volume of nearly nine hundred pages and will be of much use to systematists not only for the description of species but also for the analyses given of sub-classes, orders, families and genera which include general definitions. The type of each genus is noted but the species dealt with are only those occurring in the area studied. Most of the localities recorded relate to the Philippines, but other regions where the *Albatross* cruised, as the Netherland Indies, China, Formosa and parts of Oceania, are also listed. General and very brief notes on breeding and food in the various families are occasionally given. More of this would be welcome. The statement on p. 24 that all the Scyliorhinidæ, so far as is known, appear to be viviparous, is obviously a slip, as the egg cases and attachments to weeds and rocks are described.

Study of a Deepwater Fish

WILBERT MCLEOD CHAPMAN ("The Osteology and Relationships of the Bathypelagic Fish *Macropinna microstoma* with notes on its Visceral Anatomy", *Ann. and Mag. Nat. Hist.*, Eleventh Series, **9**, No. 52; 1942) has described previously the external anatomy of this fish (1939) and indicated its relationships with Opisthoproctus. He found, however, that there were sufficient differences from the latter to warrant the formation of a new family. A further specimen being available for anatomical study the skeleton was worked out in detail, also the gross visceral anatomy, and, to some extent, the musculature. Of particular interest are the great changes in the head region occasioned by the enormous dorsally directed eyes, the peculiarities of the oral regions, and the absence of an air bladder. The new family Macropinnidæ is proposed to include the genus Macropinna, while in the family Opisthoproctidæ the new genus Grimaldia is proposed for *Opisthoproctus grimaldi* Zugmayer. The relationships of other little-known genera are also discussed.

Accuracy of a Few Observations in a Large Population

W. L. STEVENS (*J. Genetics*, **43**, 301; 1942) points out that the customary attachment of an estimated standard error to indicate the limits of accuracy of a mean value may lead to misinterpretation in those cases where the distribution is not normal and the value is based on small numbers. Such a case is the estimate of a mutation-rate in a population N where the ratio n/N (n being the number of observed mutations) is very small. For example, the occurrence of three mutations in 1431 cultures gave a mutation rate of 0·21 per cent $\pm 0 \cdot 12$; thus a negative mutation rate would be perfectly reasonable with such a method of estimating the limits of accuracy. To overcome these difficulties, the author provides a useful table whereby the limits of accuracy of values based on less than fifteen individuals may be rapidly estimated. For genetical work and possibly in other directions this table will be of great service.

Cell Division in Small and Large Cells

E. W. SINNOTT (*Proc. Nat. Acad. Sci.*, **28**, 36; 1942) has shown that large and small cells divide and multiply at the same rate in the fruits of several cucurbits where cell division is in progress. Therefore he concludes that cell division is controlled by some factor, independent of cell size, throughout the different tissues of an organ.

Carbonization

EXPERIMENTS on the gaseous products of carbonization by heating of cellulose, glycine, petroleum coke, bakelite, anthracite and bituminous coal (K. Bolton, J. E. Cullingworth, B. P. Ghosh and J. W. Cobb, *J. Chem. Soc.*, 252; 1942) throw some interesting light on the mechanism of the process. Substances forming a solid residue form a repatterning of carbon atoms in a hexagonal network which resists any disintegrating tendency of further temperature rise and forms graphitic crystallites. It is established at 400°–500° and its progress is accompanied by a rise in density, rapid up to 800° (in coal, etc., such material is initially present). The other molecular groups form no part of this pattern or are easily detached from it, and are volatilized and expelled with rise of temperature. Some gaseous products (carbon dioxide and some carbon monoxide) appear early; the chief gaseous products (methane, hydrogen and carbon monoxide) come later and are regarded as formed from the more firmly attached CH_3, H and OH radicals by molecular condensations of the type: $R_1H + CH_3R_2 = R_1R_2 + CH_4$. The maximum emission of methane is at 500°–600°, the maximum hydrogen and carbon monoxide at 700°–800°. The latter is supposed to be formed from steam by a water gas reaction. The amounts of higher paraffins and unsaturated hydrocarbons are small with the substances tested.

Separation of Isotopes

THE separation of isotopes of oxygen and nitrogen by means of fractionating columns working with water and ammonia solutions has proved very successful. Some of these columns are very tall (60 ft. or more) and the question of packing becomes important, among other ways in that of expense. H. G. Thode and F. O. Walkling (*Can. J. Res.*, **20**, 61; 1942) have used a packing which is inert, cheap and easily wetted, which has given results and is suggested for use in industrial separation of isotopes. This was a shale which had been passed through a furnace at a temperature well above the melting point; the clinkers being crushed, cleaned and graded according to particle size. The fractionating column was tested with water and ammonia solution. In the second case a 60 per cent solution of ammonium nitrate is pumped to the top of a fractionating column at a constant rate, drains to the foot of the column where it reacts with alkali to liberate ammonia, which is stripped and returns to the column where it flows to the top against the current solution. Since ^{15}N is favoured in the liquid phase, there is a net transport of it towards the foot of the column, where it concentrates. The apparatus is worked at room temperature and 10 cm. pressure. Some figures for different types of packing are given.

Faxén-Waller Theory of Diffuse X-Ray Scattering

An elementary derivation of the Faxén-Waller formula for the diffuse scattering of X-rays by thermally excited lattice vibrations and the shapes of the surfaces of isodiffusion in reciprocal space for some cubic crystals has recently been given by H. A. Jahn (*Proc. Roy. Soc.*, A, 179, 320; 1942). It is shown that for substances with high elastic anisotropy large deviations from spherical character are to be expected for the surfaces of isodiffusion belonging to each of the individual lattice planes and, moreover, marked differences in shape between surfaces belonging to different lattice planes. The theory is illustrated by calculations made for a single crystal of sodium.

Magnetostriction

F. Brailsford and R. G. Martindale describe the results of an investigation into the magnetostriction of five grades of iron and silicon-iron electrical sheets, including a cold-rolled silicon steel and a high silicon steel (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 17, May, 1942). The silicon content varied from 0·14 per cent to 6·26 per cent. Measurements were made on strip specimens 24 in. long by 2 in. wide by 0·014–0·016 in. thick. A solenoid 20 in. long and 3 in. inside diameter was used to magnetize the strip, the magnetic circuit being completed by a massive laminated yoke. Measurements of magnetostriction were confined to a length of 5 in. at the centre of the specimen, and the variation of flux density over this length was less than 5 per cent. Changes in length were measured by a small extensometer specially developed for the purpose. Readings were made by a telescope and cross-wires on an illuminated scale, the magnification being rather more than 100,000. As the scale could be read to 0·01 in., a change in length of 10^{-7} in. could be detected. A typical maximum magnetostrictive strain of 4×10^{-6} could, therefore, be read to about ½ of 1 per cent. Magnetostriction in the sheet materials was found to vary considerably, depending upon the direction in the sheet relative to the rolling direction. The general form and direction of traversal of the hysteresis loops formed by plotting magnetostriction against flux density can also vary, depending upon the material and other factors. The theoretical analysis, while very approximate in its application to polycrystalline material, nevertheless gives some evidence for the view that, on account of the method of demagnetization or the presence of directional residual strains, the initial distribution of domains in the material in the demagnetized condition is not purely a random one. This in turn might be an important contributory factor to the magnetic anisotropy observed to occur at flux densities below the 'knee' of the magnetization curve. A number of graphs is given showing the variations of magnetostriction with changes of values of the different variables affecting the phenomenon.

mpulse Voltage Measurements

IN a paper read before the Institution of Electrical Engineers recently on measurements on impulse voltages with a ballistic galvanometer, G. W. Bowdler describes two simple circuits for measuring the crest value and duration of transient impulse-testing voltages. In the measurement of crest voltage, the impulse is applied to a resistor-divider, the voltage across a part of which is applied through a thermionic ectifier to a capacitor which is connected to the galvanometer through a series resistance. A bias battery suppresses any steady thermionic current tending to flow through the valve and galvanometer. For measuring time-lag, a fraction of the impulse voltage is applied to the grid of a triode from a resistor-divider. The galvanometer and anode battery are shunted by capacitors which have impedances negligible compared with that of the series resistance in the anode circuit. A series resistance in the galvanometer circuit isolates the galvanometer from the applied impulse voltage when measurements are being made on negative impulses. Both methods of measurement are compared with the results obtained simultaneously by a high-speed cathode ray oscillograph. The agreement in crest voltage was within 2 per cent even with voltages of the order of 10^{-7} sec. duration, and in time-lag the agreement was within 0·2 microsec. when the grid bias of the valve was suitably adjusted. The measurements are not critically dependent on the characteristics of the thermionic valves used in the circuit, and the range of voltages which may be measured can easily be extended by the use of suitable high-voltage resistors. The two circuits described have been assembled conveniently into a general impulse-measuring equipment with mains-operated supplies for the valves. As an example of its use, the time-lag curve of a 10-in. rod gap, obtained in a small fraction of the time necessary to do so by oscillographic methods, is reproduced. The paper concludes with a record of a few measurements made with this apparatus of the lengths of the front and tail of an impulse wave.

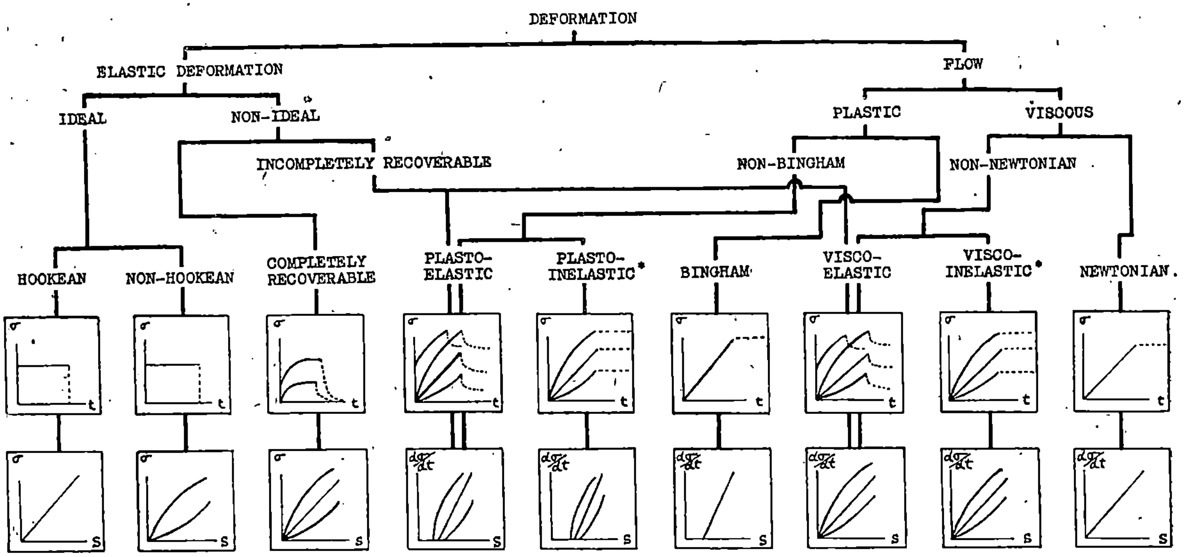
Ionospheric Measurements during Total Solar Eclipse

A. J. HIGGS has published a paper on ionospheric measurements made during the total solar eclipse of October 1, 1940 (*Mon. Not. Roy. Astro. Soc.*, 102, 1) which describes very fully the ionospheric results obtained during the eclipse, with equipment operated at Victoria West, South Africa. The conditions were particularly favourable for settling the question regarding a definite ultra-violet effect and/or corpuscular effect within the F_2 region, because the corpuscular or particle eclipse for particles travelling with the expected velocity of 1,600 km./sec. was due to take place about noon. The F_2 gradient is then generally near its maximum and the diurnal curve flat, so that any corpuscular effect should be more easily detected. In this region it was found that there was no marked corpuscular effect, but that there was an ultra-violet effect. A decrease in maximum ionization density of about 25 per cent was observed, the minimum being reached at approximately 30 minutes after totality, and these results were confirmed by Dr. J. A. Pierce of the Harvard University expedition at Queenstown. The F_1 region was well defined throughout the eclipse, and on the whole it showed the expected results, but the region is more complex than is generally supposed. A subsequent paper will provide detailed examination of the connexion between E region density and size and intensity of bright hydrogen areas. For the present, it can be accepted that the major portion of the ionization responsible for the production of region E was coming, not uniformly from the sun's disk, but from regions near observed clouds of bright hydrogen or calcium. In corroboration of this it may be noticed that observations made by the Carnegie Institution of Washington at the partial eclipse of the sun on April 7, 1940, indicated "that the Sun is not giving out the ultra-violet radiation uniformly from all parts of its surface".

CLASSIFICATION OF RHEOLOGICAL PROPERTIES

AT a meeting of the British Rheologists' Club held at the Imperial College of Science, London, on May 16, the accompanying chart was presented for discussion by the Committee. The discussion was introduced by Dr. V. G. W. Harrison (hon. treasurer).

It is believed that this classification marks a considerable advance on the earlier draft discussed at Birmingham, which was reproduced in NATURE of Feb. 14, p. 197. It incorporates many of the suggestions made by members at that meeting, and also the hatched 'frame' enclosing those categories for which the rate of deformation is liable to increase or decrease with time for constant stress is eliminated. The Committee realized that the use of this frame added considerably to the complexity of the table and that, even with it, the picture was incomplete, since another 'frame' would be required to allow for changes in the strain (σ) — time (*t*) relation with changes in stress (*S*).



(1) σ represents shear strain.
S ,, ,, stress.
t ,, time.

(2) Continuous curves represent deformation under stress.

(3) Dotted curves represent behaviour after removal of stress.

(4) Where two or more curves appear in a diagram, these indicate alternative types of behaviour.

(5) In cases marked * either the σ/*t* curve or the $\frac{d\sigma}{dt}/S$ curve may be a straight line, but not both, since in this case the systems would be Bingham or Newtonian, which are given separate categories.

(6) The upper series of diagrams in which shear strain is plotted against time represents deformations under constant stress. The lower series, in which *d*σ/*dt* is plotted against stress, is for an arbitrary time.

In order to simplify the table, Mr. D. C. Broome had been asked to draw graphs relating σ/*t*, σ/*S* and (*d*σ/*dt*)/*S* for each category showing, where necessary, the possible types of curvature which may occur in each category. These graphs, after slight revision by the Committee, have been included in the revised table. The table has also been re-arranged so that elastic deformations remain on the left-hand side throughout, the viscous and plastic deformations being on the right.

In the discussion which followed, Dr. C. A. Maunder Foster suggested that the Committee might proceed to consider the more detailed drawing of recovery curves and Mr. J. Pryce-Jones proposed that, as soon as possible, examples of materials showing each type of deformation should be quoted. Mr. J. C. Gage doubted whether the insertion of the graphs had adequately replaced the 'frame' of the earlier table.

Dr. J. Needham asked whether the complex rheological properties described by him in a paper read earlier in the day could be fitted into the table, and Mr. L. Bilmes submitted a circular form of the table, which the Committee will consider in the near future.

Replying on behalf of the Committee, Dr. G. W. Scott Blair (hon. secretary) said that he did not think that it would be possible to explain all kinds of complex rheological behaviour in terms of the present table. The Committee has taken as its first task the formulating of a table of types of deformation. It is hoped that with the help of members and of colleagues in the (American) Society of Rheology, the scope of classification of properties may be extended, but for the present the effective range of activity is limited. It is realized that the categories in the table cannot be regarded as hard-and-fast limits of behaviour, but rather as convenient landmarks, analogous in many ways to the psychologist's classifications of character and personality types. It would be rash to regard intermediate systems as, of necessity, mechanical mixtures of the simple types between which they lie. As soon as the categories are found to be acceptable, the Committee will consider the possibility of designating each type by means of a letter or number.

Any one who may wish to make criticisms or suggestions with regard to the above table is invited to communicate with the honorary secretary of the British Rheologists' Club, c/o Institute of Physics, University of Reading.

INSULATING OILS

IN a symposium on insulating oils, five important papers were presented before the Institution of Electrical Engineers in London on May 13 by various authors. In the first one, on "Manufacture and Testing of Oils and Oil-Rosin Saturants for use in Electrical Equipment", A. W. Thompson and J. C. Wood-Mallock described briefly the selection of oil crudes, and the choice of refinery methods best suited for the manufacture of transformer and switch oils, and condenser and cable saturants. Methods of test are discussed and consideration is given to the changes undergone by these liquid dielectrics under high electrical stresses.

Highly paraffinic oils are undesirable in transformers, cables and condensers, and therefore solvent processes are, in general, unsuited to the production of such oils. Rosin is a desirable constituent of cable saturants. It is concluded that in respect of transformer oils, revision of British Standard 148, particularly of the oxidation test, is overdue. Any proposed oxidation test should take account of acidity development as well as sludge, and should be carried out at a lower temperature. Solvent treatments lend themselves to production of transformer oils having the desired characteristics, but the distillate must be chosen for the purpose. For switch oils, further work is required on carbon production during arcing and its relation to refining.

For condenser saturants transformer oil is not ideal. They should be judged on the basis of dielectric loss and stability to ionic bombardment. Sulphuric acid treatment of a naphthenic distillate, which may have a reasonably high viscosity, is the best method of production. In cable saturants for solid-type cables the oil component should be assessed on power loss, particularly at high temperatures, and freedom from gas formation under electrical stress. A suitable oil is prepared from a viscous vacuum distillate from a naphthenic or intermediate crude, by sulphuric acid refining. Solvent processes are unsuitable. Rosin is a desirable constituent because of its effect on gas formation and cable stability, and should be chosen with regard to its effect on dielectric loss.

The second paper, "Insulating Oils for Cables", by S. Beckinsale, indicated the present position in Great Britain of the insulating oils and compounds available for cables, and described their behaviour in impregnating plants. The oils in question are of the paraffinic and naphthenic types, and either class may be used in oil-rosin compounds. Naphthenic oils are the better solvents for rosin and for the oxidized bodies produced from rosins, and their use is increasing rapidly. All the oils and compounds can be prepared with excellent electrical properties, but as some of their constituents are very subject to chemical change in the presence of air, the cable-making plant and processes must be types which reduce this interaction to a minimum. For voltages up to and including 66 kv. the various oil-and-rosin compounds are employed, but for higher voltages either a thin naphthenic oil is used for the oil-filled cables, or a viscous naphthenic oil, sometimes containing a viscous hydrocarbon polymer, is the saturant for the pressure-type cables.

Cable oils should be resistant to gassing, and both British and American oil refiners leave in certain aromatic constituents which absorb any gas that may be generated under electrical stress from the more saturated compounds in the oil. Solvent-refined naphthenic fractions have been found suitable for cables, but the solvent-refined paraffinic fractions have proved unsuitable owing to their failure to absorb gas and to the physical instability of their rosin compounds. The use in Great Britain of oil-rosin compounds for the impregnation of cables for voltages up to 66 kv. is based on their increased viscosity combined with the excellent impregnation and good adhesion between compound and paper fibre. In the early 1920's, papers made from cellulose from the conifers were developed, for it was considered that as resinous substances had been present in the cells in the tree, such cellulose with its characteristic cellular structure would have a greater affinity for rosin than the cellulose produced from such fibres as manila and cotton. The use of this wood pulp has now become almost universal for power cables.

The further improvement of oils and rosins for cables is largely a problem for chemists and physicists, with electrical engineers in the background testing the results obtained from new processes and, where necessary, working out new methods of test as the dielectric losses are reduced.

The third paper of the series, by W. Fordham Cooper, on "Insulating Oil in Relation to Circuit-Breaker Failures", is based upon the author's investigations in the course of the last ten years of a considerable number of accidents and dangerous occurrences due to the explosive failure of oil circuit-breakers and oil-immersed control gear, in the course of which it has become apparent that not all were due to inadequate rupturing capacity or defective insulation. This has been true particularly of a number of failures in recent years of the control gear for arc furnaces. The paper assesses what part deterioration of the switch oil may play, and the importance of the problem may be judged from the fact that oil in such switches is now frequently changed every two or four weeks, and, at some works, once a week.

Many engineers responsible for the maintenance of switchgear have felt that while the tests laid down in British Standard specifications may eliminate many new oils which are definitely unsuitable, they provide no certain guide to the rejection of used oil after a period of service. The author therefore includes a section suggesting the initial tests which might be taken in the search for a more suitable basis. Explosions occur occasionally without previous insulation breakdown or severe arcing, and it is necessary to correlate their occurrences with some definable condition of the oil or the switch.

The study is divided into two parts: (i) surface contamination and the associated presence of suspended matter in the oil; and (ii) general chemical deterioration of the oil. There are then four aspects of each of these, namely, reproduction under controlled conditions of the phenomena observed in the field; laboratory examination of new and used oil, and correlation of the result with experience of breakdown; development of comparatively simple tests for the rejection of seriously defective oil; the determination of whether repeatedly 'cleaning' oil by conventional methods renders it safe for re-use, or whether cumulative effects of chemical change may, after a time, lead to danger. In the initial stages the second and third aspects mentioned above must progress together so that, if possible, a correlation is established between simple tests and those requiring the services of a skilled chemist.

The next contribution is on "Mineral Oil for Transformers and Switchgear", by A. A. Pollitt, in which the author sets out to familiarize the electrical engineer with the nature and characteristics of mineral oils. In spite of the advent of non-inflammable, liquid-chlorinated hydrocarbons, mineral oil still remains the chief dielectric used in liquid-filled transformers and switches. Mineral oil has been chosen because of its high electric strength compared with that of air and because, where necessary, it can function as a cooling medium and so maintain the operating temperature of the equipment at a safe value. The outstanding characteristic of mineral insulating oils is their stability in service. Efficient operation of mineral-oil-filled electrical equipment is dependent, therefore, to a large extent upon the ability of the oil to retain substantially unimpaired, in the presence of deteriorating influences, its initially good electrical properties, its inertness towards the solid insulating materials that are also present in most electrical equipment in which oil is used, and its ability to effect efficient cooling.

The author deals with the constitution of mineral insulating oils, refining, causes of deterioration, oxidation products and their influence, the evaluation of insulating oils, and oils in service.

The last paper, on the "Maintenance of Insulating Oils in the Field", by L. H. Welch, reminds one that insulating oil deteriorates in use and the maintenance engineer must see that the working conditions are such as to minimize this. The oil must be reconditioned when the necessity is revealed by regular observations on its condition. Reference is made to points which should be watched in the design and installation of plant and it is suggested that, of the oils specified in British Standard 148–1933, only grade *B*.30 should be retained. The revised specification should include high-viscosity oils which are frequently used in electrical apparatus. Routine tests for sludge and moisture contamination are universal, but determination of acid value may be important and the flash-point has to be determined occasionally. Suggestions are made as to what values of these should be permitted before purification is considered necessary. The type of contamination likely to be present and the apparatus available for its treatment and various methods of using it are discussed. A table showing suitable maintenance periods is given, and it is pointed out that as it is difficult to handle oil and to work on oil-immersed gear without causing deterioration, these periods depend more on the immersed apparatus requiring attention than on the oil.

Oil maintenance can be kept to a minimum by giving attention to the following points: minimum operating temperature of transformers and kindred apparatus to be ensured by adequate ventilation for indoor equipment and correct adjustments of controls on forced cooling systems; adequacy of breathers, and their maintenance; careful selection of mechanical and electrical design of apparatus, particularly in relation to tap-changing gear; use of grade *B* oils—grade *A* oils have proved liable to develop excessive acidity and sludging in service whereas grade *B* oils have developed less total acidity and less total sludging and should, therefore, be used wherever oil of this viscosity is required; such oils can be expected to prove a reasonable cure for acidity and sludging, which have occurred where grade *A* oils have previously been used; cold purification is much to be preferred and a filter is generally more useful and easier to operate than a centrifuge.

Finally, it is considered that the present British Standard 148 requires revision. It covers six oils of the same viscosity and these could all be replaced by *B*.30 oil. There is need to include other oils, however, particularly a more viscous oil for switchgear.

INSTITUTION OF ELECTRICAL ENGINEERS

THE report of the Council for the year 1941–42 of the Institution of Electrical Engineers discloses that 1,650 new members were elected during the year and that there are now 10,483 corporate members on the register. An Installations Section was inaugurated during the year with an initial membership of 1,127. There are now nine students' sections aggregating a membership of 4,483, which includes 1,944 graduates.

Post-war planning continues to receive attention and a joint committee has been set up consisting of two representatives of each of the three engineering institutions, while contact has also been made by the planning committee with a number of other organizations which are discussing planning problems. Co-operation with the Ministry of Labour and National Service in the working of the Electrical Engineering Section of the Central Register continues and 1,121 members have been placed on work of national importance. Reference is made to the Institution's part in the intensive training courses in engineering, which are designed to carry men from the Ordinary National Certificate to the Higher National Certificate standard in six months. Co-operation with the Institution of Mechanical Engineers has been promoted in this connexion.

More than two thousand members of all classes are on active service with the Forces, and arrangements have been made for ensuring that those liable for military service are posted to appropriate technical branches of the Forces. More than three hundred applicants for technical commissions in the Forces have been dealt with; two hundred cases were presented to the Beveridge Committee with the view of up-grading or transfer to duties in the Services more appropriate to the member's qualifications. More than 4,500 enrolments have been accepted by the War Office from men in the Army and the R.A.F. for tuition in various engineering courses under the scheme set up by the three engineering institutions, the Board of Education and the Service Departments.

Other activities upon which the Institution has been engaged are the preparation of codes of practice, war emergency standards, A.R.P. in the engineering industry, the statistical control of materials and manufactures, and fuel efficiency and economy. On the educational side, in collaboration with the Institutions of Civil and Mechanical Engineers, a joint panel of senior engineers has been formed for the purpose of delivering lectures to university engineering societies, in order to bring students into touch with actual practice. A centre of the Polish Society of Electrical Engineers, with headquarters in London, has been formed and the Institution's premises have been placed at its disposal for meetings, etc.

Associate membership examinations were held for 538 candidates and, in English only, for 193 holders of National Certificates in electrical engineering. Arrangements have been made with the British Red Cross Society for prisoners of war in Germany to sit for the associate membership examination in prison camps. 1,065 national certificates and diplomas in electrical engineering were awarded during the year.

297 books and pamphlets have been added to the Institution's reference library and 58 new volumes to the lending library. Subdivision of the *Journal* came into effect in January 1941, Part 1 being distributed free to members; more than 6,000 members subscribed for Part II and some 4,000 for Part III. *Science Abstracts* continue to be published monthly in two sections, Section 'A', dealing with physics, and Section 'B', with electrical engineering. The universal decimal classification has now been adopted in both sections, as from January 1942. 1,045 copies are issued each month to members and 6,720 copies per month to others.

FOLK-LORE OF VENEREAL DISEASE

IN a recent article (*Brit. J. Ven. Dis.*, 18, 1; 1942) Dr. J. D. Rolleston attributes the scarcity of the folk-lore literature on venereal disease partly to the fact that most medical practitioners know little and care less about folk-lore, and partly to the fact that folk-lorists are rarely medical practitioners and shrink from dealing with what they regard as an unsavoury and repulsive subject. No mention of venereal disease, for example, is to be found in W. G. Black's "Folk-Medicine" (1883) or Sir James Frazer's "Golden Bough" (3rd ed., 1927–36), the two principal works by lay writers, in which much valuable medical folk-lore is to be found, while of the two chief works in Great Britain by medical authors, namely, Pettigrew's "Superstitions Connected with the History and Practice of Medicine and Surgery", published in 1844 or two years before the term 'folk-lore' was invented by William John Thoms, does not mention venereal disease at all, and the comparatively recent work by Dan McKenzie on "The Infancy of Medicine" (1927) has only two brief references to the subject.

The only important treatise on medical folk-lore in which the subject of venereal disease is adequately discussed appears to be that of O. V. Hovorka and A. Kronfeld (1908–9) entitled "Vergleichende Volksmedicin". Owing to the comparatively recent establishment of their autonomy, there does not seem to be any folk-lore connected with chancroid or the fourth, fifth and sixth venereal diseases, so that Dr. Rolleston's paper deals only with syphilis and gonorrhœa.

As regards nomenclature, the term 'syphilis', which was introduced by Fracastoro in 1521, did not at first receive general recognition and during the whole of the seventeenth and eighteenth centuries only about half a dozen writers employed it. Although, however, no scientific term was given to the disease, on its first appearance in Europe a host of new names was introduced by the laity, the commonest being those indicating that the malady had originated in France. Popular theories as to its origin included the views that the disease had a divine source, being a punishment for unchastity, that it was due to intercourse between a man and an animal or that it was caused by intercourse with a woman who was menstruating or had a vaginal discharge of any kind.

Belief in a cure of a disease by transfer of it to another person or animal is a well-recognized tenet of medical folk-lore, but whereas in the case of other complaints such as epilepsy, whooping cough, warts, boils, pulmonary tuberculosis and the acute exanthemata, the transfer is purely imaginary, in venereal disease, especially gonorrhœa, it only too frequently actually takes place without, of course, having any curative effect. The person to whom the disease is transferred is preferably a young virgin of either sex, much less frequently an adult. This superstition, which dates back for several centuries, is world-wide. Other folk-lore methods of treatment for venereal disease include animal and plant remedies and miscellaneous cures which in the case of syphilis include sweating and fumigation, and local application of drugs or other substances. In the case of syphilis but not of gonorrhœa, several patron saints may be invoked, while in gonorrhœa but not in syphilis coprotherapy is sometimes employed.

COLLECTIVE FARMING IN RUSSIA AND THE UKRAINE

SIR JOHN RUSSELL has made a study of Russian agriculture, and, through his visits to that country from time to time, has been able to observe trends in agricultural policy, and the results of the State and of collective farms. He discussed his observations in a lecture recently delivered at the Royal Institution.

It was impossible to arrive at once at the most desirable system of land utilization, this being influenzed by progress in farming methods, particularly as regards mechanization, and the effect of this on the growth of the workers' interest in the State or collective unit, as opposed to his own personal stake in the land. The application of modern machinery to tillage, and of methods of livestock improvement and disease control to herds and flocks are more suited to large than to small units, and it is probable that success in these directions influenced the workers' views as to the extent to which they were prepared to identify their own interests with that of the large unit in which they are employed.

After the Revolution, State farms were developed, but the peasants, who expected nothing less than individual ownership of the land that they tilled, were not then sufficiently mature, either politically or technically, to make a success of this form of organization. Instead of the State farm, the collective farm figured more and more prominently in the development of Soviet land policy. Thus, by 1939, the area occupied by collective farms was more than eleven times that of State farms.

Collectivization is based on the principle that an entire village, with its land, is run by the inhabitants as one farm, boundaries being obliterated, and the whole area divided into a few fields, the number depending on the rotation. All possessions are pooled, and the workers share the produce remaining after paying out the Government share, and meeting other obligations. Collectivization at first met with great opposition, particularly owing to the compulsory pooling of all livestock; peasants who, by years of hard work and economy, had got together a cow and a few pigs, found it difficult to have to restart from the same level as those who had never made any sacrifice to provide their families with livestock necessary to maintain them in milk, butter, and other produce. For this reason, collectivization at first resulted in a heavy decrease in the numbers of livestock. The opposition to collectivization decreased when the benefits of the tractor in large-scale farming were realized, and, later, by the action of the State in securing the land to the collective farm for ever, and in giving to each householder a small plot of land, a cow, one or two pigs and poultry. The peasant of the collective farm is allowed to sell the produce of his plot and of his stock. A worker's time is shared between the collective farm and his own plot, and, in the same way, his income is derived from those two sources.

Sir John gave some data showing the proportion of workers' time spent on the collective farms, the proportion of his total income derived from that source, and the influence of efficiency in the management of the collective on the proportion of his total earnings derived from it. It has become necessary, in some instances, to enforce a minimum of two hundred working days per annum on the collective farm, in order to prevent the peasant from devoting too much of his time to his own plot and stock.

The most important feature of the new system, however, is that production is planned, each farm being told what, and how much, to grow for a period of five years. Requirements are allocated to the different districts, and each farm in the district is allotted its area for the various crops, and told what quantities of animal products are expected of it.

Great efforts are made to utilize science. Thus, extensive soil surveys are carried out, and made use of in developing rotations; one important result of this is a reduction in the area of fallow from 35 per cent under the old three-course system to 20–25 per cent now that rotations are practised. Science also plays a part in the struggle against drought; the importance of this can be understood when it is realized that in large areas in the south the average annual rainfall is not more than 12 inches.

The standard of comfort and of living of the Russian farm workers has not reached that of the British land worker. Houses are smaller, and are not so well furnished. The diet is simple, and would be considered monotonous by many standards. Great strides have been made in education, and by 1939 the ladder was complete, every child having an opportunity of university education.

The author has succeeded in presenting the reader with a brief but clear picture of the lines along which Russian policy is developing. The results of collective farming are discussed, and there is an interesting account of life in a Russian village, or collective farming. E. J. ROBERTS.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PATHOLOGIST AND DIRECTOR OF THE CLINICAL RESEARCH LABORATORY—The Secretary and Treasurer, Victoria Infirmary of Glasgow, 40 St. Vincent Place, Glasgow, C.1 (June 27).

MASTER (OR MISTRESS) TO TEACH MATHEMATICS, MECHANICS, SOME SCIENCE, AND ENGLISH at the Junior Technical School of the Wellingborough Technical Institute—The Secretary for Education, County Education Offices, Northampton (June 27).

ASSISTANT SCIENCE MASTER, GRADUATE, TO TEACH PHYSICS PRINCIPALLY, at the Junior Technical School for Boys—The Director of Education, Education Office, Leopold Street, Sheffield 1 (June 27).

TEACHER OF BUILDING CONSTRUCTION, SCIENCE AND MATHEMATICS, at the Oxford Schools of Technology, Art and Commerce, Building Trades and Junior Day Departments—The Chief Education Officer, City Education Offices, 77 George Street, Oxford (June 29).

HONOURS GRADUATE IN ENGINEERING at the Quakers' Yard Technical School—The Director of Education, Education Department, Town Hall, Merthyr Tydfil (June 30).

LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (June 30).

MISTRESS TO TEACH PHYSICS AND CHEMISTRY at the Wellingborough High School—The Secretary for Education, County Education Offices, Northampton.

ASSISTANT FOR MATHEMATICS, and an ASSISTANT FOR SCIENCE WITH ELECTRICAL ENGINEERING, if possible—The Principal, Technical Institute, Longport Street, Canterbury.

FORTHCOMING EVENTS

Saturday, June 20

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES BRANCH) (at the South-West Essex Technical College, Forest Road, Walthamstow, London, E.17), at 2.30 p.m.—Conference on "The Eye in Industry".

Monday, June 22

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Empire Cotton Growing Corporation. Annual Report for the Season 1940–1941. Pp. ii+18. (London: Empire Cotton Growing Corporation.) [56

Annual Report of the Zoological Society of Scotland for the Year ending 31st March 1942. Pp. 29. (Edinburgh: Zoological Society of Scotland.) [86

Other Countries

Ministério de Trabalho, Indústria e Comércio: Institutó Nacional de Tecnologia. Publicação 70: As argilas descorantes e sua ativaçao tecnologia, análises e aplicações. Pela Yvonne E. Stourdzě. Pp. 103. Publicação 71: Sobre uma substância graxa do litoral do Piauí. Pela Camilla Rolin. Pp. 16. Publicação 72: Desenvolvimento da técnica para a determinação do volfrâmio em seus minérais. Pela Antonietta de Larmo Cantição. Pp. 13. Publicação 73: Dosagem do fósforo pelo método de N. v. Lorenz (Com a dosagem volumétrica segundo F. Scheffer). Pela Yvonne E. Stourdzě. Pp. 40. (Rio de Janeiro: Institutó Nacional de Tecnologia.) [26

Sudan Government: Wellcome Chemical Laboratories, Sudan Medical Service, Khartoum. Report of the Government Analyst for the Year 1940. Pp. 22. (Khartoum: Wellcome Chemical Laboratories.) [36

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 8): Supervision of Elementary Education as a Function of State Departments of Education. By Helen K. Mackintosh. (Studies of State Departments of Education.) Pp. vi+86. 15 cents. Occupational Information and Guidance Service, Leaflet No. 6: Medicine. By Walter J. Greenleaf. Pp. 24. 10 cents. Vocational Division Bulletin No. 215 (Occupational Information and Guidance Series No. 7): The Individual Inventory in Guidance Programs in Secondary Schools; a Study of Present Practices in Selected Schools. By Eugenie A. Leonard and Anthony C. Tucker. Pp. v+60. 15 cents. (Washington, D.C.: Government Printing Office.) [86

Proceedings of the United States National Museum. Vol. 92, No. 3137: Descriptions of Five New Species of Chalcidoidea, with Notes on a Few Described Species (Hymenoptera). By A. B. Gahan. Pp. 41–51. (Washington, D.C.: Government Printing Office.) [86

Cornell University: Agricultural Experiment Station. Bulletin 763: Soils in relation to Fruit-Growing in New York, Part 15: Seasonal and Soil Influences on Oxygen and Carbon-Dioxide Levels of New York Orchard Soils. By Damon Boynton. Pp. 43. Bulletin 764: Consumer Buying of Potatoes and Store Offerings. By Alida S. Hotchkiss. Pp. 34. Bulletin 765: The Demand for Milk and Cream as revealed by Consumer Purchases at Retail Food Stores in New York City. By Charles J. Blanford. Pp. 47. Bulletin 767: A Study of Dairy-Farm Management in Onondaga County, 1938 and 1939. By R. W. Hoecker. Pp. 21. Bulletin 768: The Transmission of Farming as an Occupation. By W. A. Anderson. Pp. 29. Bulletin 769: Agricultural Production in New York, 1866 to 1940. By T. E. LaMont. Pp. 36. Bulletin 770: Control of White Grubs in Strawberries. By Theodore W. Kerr, Jr. Pp. 40. Bulletin 771: Measurements and Weights of One Hundred Cows in the Cornall Dairy Herd. By E. G. Misner. Pp. 21. Bulletin 772: The Winter Hardiness of some Ornamental Woody Plants in New York State. By John F. Cornman. Pp. 32. Bulletin 773: Changes in the Prices of Apples and other Fruits. By M. D. Woodin. Pp. 25. Bulletin 774: Relative Economy of Nutrients in Servings of some Commonly Used Foods. By Barnara Barber Kennedy. Pp. 18. Memoir 240: Studies on the Biology of Four Common Carpet Beetles. Part 1: The Black Carpet Beetle (*Attagenus piceus* Oliv.), the Varied Carpet Beetle (*Anthrenus verbasci* L.), and the Furniture Carpet Beetle (*Anthrenus vorax* Waterh.), by Grace H. Griswold; Part 2: The Old-fashioned Carpet Beetle (*Anthrenus scrophulariæ* L.), by Margaret Greenwald. Pp. 75. (Ithaca, N.Y.: Cornell University.) [116

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HEALTH SERVICES AND POPULATION PROBLEMS

THERE could be no better illustration of the extent to which the importance of the health of the nation is now generally realized than the general support which the broad policy of the Ministry of Food has received, as indicated in the lecture of Prof. J. C. Drummond on "War-Time Nutrition and its Lessons for the Future" delivered before the Royal Society of Arts on May 6 (*J. Roy. Soc. Arts*, 90, 422, 1942), or than the declaration of some two hundred members of Parliament of all parties in favour of family allowances. Even the General Council of the Trades Union Congress, long the backbone of opposition, is now in favour of a State scheme, and resolutions in favour of a scheme of family allowances, and the right to all forms of medical attention and treatment through a national health service, were passed at the annual conference of the Labour Party in London. The general principle of family allowances in the form of cash payments from national funds was also approved at the Co-operative Congress in Edinburgh on May 25.

The somewhat non-committal memorandum of the Chancellor of the Exchequer (see NATURE, June 13, p. 656) makes its belated appearance when the ground is at any rate cleared for consideration of the application of the general principle to concrete schemes or proposals. This advance in opinion may fairly be attributed to a development in the general outlook on public health corresponding with that which has characterized the medical profession itself in the last two decades, with the change in emphasis from remedial to preventive measures. There is widespread recognition that disease is largely preventible, that malnutrition is a conspicuous factor in many diseases, and that the main causes of malnutrition are ignorance and poverty, with the emphasis on the latter. This undoubtedly has been the chief factor in overcoming opposition to the idea of family allowances. They are welcomed above all as a contribution to the health of the growing generation, and as Prof. Drummond has shown in his lecture, the success of many of the measures adopted to safeguard the nutrition of the nation in war-time is now widely recognized as too valuable to be discarded when victory is won. Prof. Drummond's emphasis on the value of the canteen and of the 'British Restaurant' is supported by a P E P broadsheet on "Health in War-Time" which appeared last year. Like the allotment movement, they can fill as essential a role in peace-time as under war conditions. He sees in these two types of communal restaurant the essence of what might become, with competent handling and appropriate guidance, one of the strongest links in our industrial machine—the health and efficiency of the workers of Great Britain.

It needs but little imagination to realize how powerfully such a development could contribute to that other outstanding matter discussed by Prof. Drummond—education on food and food values.

His lecture gives an inspiring glimpse of the possibilities if such education is not confined to the general population, but is inculcated effectively in the medical and nursing professions. This vision of a campaign to be launched in the United States for promoting good health by ensuring good nutrition holds great implications for Great Britain in agriculture as well as in industry and in health if that example is followed. The consequent expansion of agriculture is exactly of the type which keys in efficiently with town- and country-planning, the reconstruction of the countryside and the most efficient use of our natural resources of land.

Much, it is true, has to be done, as Prof. Drummond himself has shown, before public opinion is ready for such developments. Hospitals and medical men alike in Great Britain are lamentably behind institutions and colleagues in the United States and in Canada in the scientific planning of diet and attention to the prevention of disease by good food. Interest is growing, however, and might be powerfully stimulated by adoption of suggestions such as Prof. Drummond advances in regard to the foundation of chairs in our medical schools for lectures on the prevention of disease in this way as a part of the clinical training of every student, and for the sending out to each of half a dozen countries of small, qualified and equipped teams of young medical men and nutrition experts, trained to correlate on the spot information about diet and the incidence of disease.

Satisfactory evidence of that growing public interest, moreover, is to be found in the debate on hospital administration in the House of Commons on April 21. The question was raised on a motion relating to the regional planning of hospital services by Mr. McNeil, and it was very clear in the debate that the opportunities which the War has given us of establishing out of the Emergency Hospital Service a much more effective hospital service for the whole community are very much in the minds of members of the House of Commons. Mr. McNeil, for example, considers that both in respect of medical and nursing personnel, the War would give us reserves for any expansion on which we might decide; there is in the Services at present a great reservoir of young professional men who will come out with much more administrative experience than their normal professional life would have afforded.

The main emphasis in Mr. McNeil's speech, however, was on the regional aspect of our present hospital system, with reference to the cure and prevention of disease, and the ways in which regionalism can be used to provide the extensions and the elasticity required in our present system. Whatever anxiety may be felt by some local authorities as to the size and pattern of the regional scheme, its administration and finance and its identity with the Civil Defence region, the necessity of regionalism is now generally admitted. Unit borders may require re-definition from time to time in accordance with the re-allocation of industry and the movement of population, and while the existing units of the Emergency Medical Service may well be acceptable for some time to come, in the post-war years the units should at least be open to reconsideration in relation to the planning of physical reconstruction under the Ministry of Works and Planning. Objections to regionalism, as Mr. McNeil suggests, are likely to diminish the more readily with a wise degree of devolution in the administration of the units.

Mr. McNeil stressed the importance of health centres, an efficient educational scheme in health and industrial health officers. Moreover, Mr. Frankel, referring to the announcement that a new site for Charing Cross Hospital has been purchased and that plans are ready, asked for a categorical assurance from the Minister of Health regarding the planning and siting of new hospitals. They must be located in areas where they are most likely to be needed, in accordance with a definite policy intimately related to the building and reconstruction plans being prepared by the Ministry of Works and Planning.

In his reply, the Minister of Health, Mr. Ernest Brown, was scarcely as specific on this point as might be desired, but he reiterated his previous statement as to the Government's intention to continue the partnership between the local authorities and the voluntary hospitals. In affirming his support for a positive and not a negative policy in the field of health, he gave the assurance that the Emergency Hospital Scheme would be fitted into the general scheme. While he declined to commit himself to any definition of the regional unit, it was made clear that the intention is to promote co-operation between a county branch and the teaching or central hospital, and to avoid overlapping and uneconomical expenditure by securing the provision of highly specialized services at teaching hospitals and other centres selected to serve these wider areas, and by arranging for a proper division of functions between the hospitals in those areas. The existing hospital system in the county boroughs, with the exception of a few of the largest towns, cannot provide the enlarged and full facilities in the way of hospital treatment which modern science has put at our disposal, and any attempt to provide them town by town would be grossly uneconomic. In planning our lay-out of hospitals, we must accordingly look to wider areas, said Mr. Brown, and see that all future accommodation provided, whether by municipal or voluntary effort, forms part of a new public health hospital service, set up not haphazard but in accordance with a general design.

The House of Commons debate demonstrated beyond question that the idea of preventive medicine is rapidly gaining ground, and also the general desire to build on existing experience and develop the present system to serve the new needs as they become clearly seen. The same emphasis on the preventive aspects of the health services recurs in a pamphlet on "National Health Services and Preventive Methods for Improving National Health", by Dame Janet Campbell and Dr. H. M. Vernon recently published by the British Association for Labour Legislation. Mr. H. Graham White, in an introduction, directs attention to the implications for a national health policy of the overhaul of our social insurance schemes already in progress—a real extension of national health insurance, reorganization of our hospitals system and a change in the position of the medical profession in the community. Dr. Janet Campbell attempts an analysis of the situation to encourage the ordinary citizen to think out the problem from his own point of view, and to bring an intelligent judgment to bear on whatever schemes may be advanced for reorganized health services to promote better health and higher physical efficiency. From this admirable emphasis on the necessity of educating public opinion, Dr. Campbell's survey of existing services leads her, after an incidental reference to the social factors and services also involved, to discuss the possibilities of a national medical service in which a service of whole-time medical men and women would replace the present panel service by a scheme providing both domiciliary treatment for all who need it and any necessary consultant and hospital services. To secure conditions of work which would be attractive to a first-rate medical man and offer encouragement for reasonable specialization, opportunities for promotion or hospital service, post-graduate study, etc., Dr. Campbell visualizes a unit such as a team of medical men, each specializing in some branch of particular interest to him, and based on a well-equipped clinic or health centre, which would largely replace the out-patient department of the general hospital.

Such a clinic would be supplemented for special purposes by the school clinic, venereal diseases clinic and tuberculosis dispensary, where these are to be found. Dental treatment would be an essential auxiliary service, while physiotherapy, home-surgery and a social service for follow-up work and after-care would be required. Adequate staffing of the clinic would ensure that the medical practitioners had reasonable leisure as well as sufficient time for the needs of each patient and for keeping in touch with the advance of medical science. On the other hand, no patient would fail to obtain prompt medical assistance because of poverty, or be required to pay for special treatment in excess of his capacity.

It would, of course, be necessary to determine how far such a scheme should be available, and also its relations with the public health services. Clearly it cannot be limited to the insured worker. It must be open to all families below a certain income-level, and replace the panel service, the district medical service under public assistance and largely the out-patient work of the general hospital. Moreover, the wider it is open to voluntary contributors able to pay, in part or for the whole of treatment, the stronger would be the financial side of the scheme and the more readily class distinctions would be removed and the disastrous idea of differing standards of treatment for panel and for private patients.

Close and friendly relations with the public health services are essential. Moreover, there are certain duties which might now well be entrusted to general practitioners of the national medical service—Dame Janet Campbell points to school medical work as an example. In regard to administration, while a national medical service would probably be administered by a central Government department and financed from national revenue rather than local rates, she emphasizes the importance of regional and local administration so far as possible, and of the delegation of all purely professional matters to a fully representative medical sub-committee. Her suggestions are reflected in the House of Commons debate, and she reiterates the importance of organizing a national nursing service as part of a national medical service, under which a scheme for the superannuation of nurses who have given recognized services could be established.

There is plenty of evidence that the medical profession itself recognizes the need for reform and reorganization of the medical services. Lord Dawson of Penn's address before the Medical Society of the Military Hospital, Shaftesbury, on "Medicine and the Public Welfare", is only one example of the way in which medical opinion is prepared to consider fundamental changes in the present arrangements and to work out the arrangements which would give us, in a framework planned to secure order but also elasticity, the individuality and freedom which mean life and evolution. Dame Janet scarcely sustains her plea for a Ministry of Medical and Nursing and Social Services, separated from the Ministry of Health, to organize post-war medical reconstruction. With a Minister of Health who is genuinely interested in medical and social questions, and willing and resolute to see the task through, the essential readjustments or transfer of powers between Ministries and Departments could well be better effected by a closer adhesion to the principles of the Machinery of Government Report.

Dr. Vernon's survey in the same pamphlet of preventive methods for improving national health is concerned primarily with industrial health, and he travels over ground which has been covered in several reports from the point of view of production during the last year or so. Social environment, he concludes, is a much more potent factor than occupational environment in controlling the health of the nation, and once again the fundamental importance of social and economic factors in relation to the health of the nation receives emphatic endorsement. It is against such a background that the question of family allowances must now be considered.

The Chancellor of the Exchequer's White Paper of May 7 endeavours to show the fiscal cost of a five-shilling-a-week allowance, now that for important sections of otherwise widely divided opinion the question of relating income to the extent of family responsibilities by means of family allowances has become, not whether there should be a scheme, but how best it can be applied. On such points as the cost of a scheme, its financial resources, its administration, its relation to existing partial schemes and how it could be supplemented by voluntary schemes, the White Paper supplies facts and figures. It is clear that the difference between the cost of allowances with a means test and allowances to all children is slight, compared with the total cost. This should be decisive in view of the objection of the Trades Union General Council to any scheme involving a means test, against which there is much to be said on the ground both of equality and simplicity, particularly when the expenditure should be socially productive.

Much the same objections would apply to any contributory scheme, and if a reduction in cost is considered imperative, the most effective and practicable method would probably be to withhold the benefit from small families. There are precedents in the schemes of other countries for excluding the first child, but the social surveys in recent years which have brought out the relation between size of family and the poverty line have put the case for family allowances as a remedy for poverty on such a new footing that a generous scheme may well be the soundest policy. Moreover, the population situation provides a powerful argument for a generous scheme. Before reaching a decision at the present it would clearly be desirable, as the Chancellor points out, to explore the alternatives to a system of cash allowances, when the problem may be less one of cash than of supplies—alternatives which the White Paper unfortunately does not proceed to examine. Nevertheless, the Government could scarcely take any single step open to immediate adoption that would go so far as a system of family allowances both to mitigate poverty in its most distressing form, and to convince public opinion that it is taking serious thought for the future generation and is prepared to undertake far-reaching reorganization and development of the health and related social services.

ALFRED NORTH WHITEHEAD

The Philosophy of Alfred North Whitehead

Edited by Paul Arthur Schilpp. (The Library of Living Philosophers, Vol. 3.) Pp. xix+745. (Evanston and Chicago: Northwestern University, 1941.) 4 dollars.

THIS volume provides a guide to Whitehead's published writings, an explanatory commentary upon them, and criticisms of the objections to which they may be considered to lie open. It had been hoped that Whitehead would reply to the criticisms. Unfortunately a serious illness has prevented him from doing so. Instead he has contributed some delightfully characteristic "Autobiographical Notes", and a letter (reproduced in facsimile) in which he has suggested that the outcome of this volume, had health and age allowed, would have consisted in his "devoting many years to rewriting [his] previous works". Two of his philosophical papers, not previously published, are also given, on "Mathematics and the Good", and on "Immortality".

The twelve autobiographical pages are a treasure in themselves; and happily the setting is worthy of them. The expository and critical articles, making up the body of the volume, are eighteen in number. Partly by pupils and disciples, but mainly by scientific and philosophical colleagues in the United States and Great Britain, they one and all aim at a *critical* account of Whitehead's teaching. Much the longest (pp. 15–125), and also quite the most important, of all the contributions is that of Victor Lowe on the "Development of Whitehead's Philosophy". It is an interpretation and critical discussion of the successive phases of Whitehead's teaching as recorded in his published writings alike in the pre-philosophical period that opened with his "Treatise on Universal Algebra" (1898) and in the series of philosophical works that opened with his "Enquiry Concerning the Principles of Natural Knowledge" (1919). Dr. Lowe answers many questions which must have been in the minds of Whitehead's readers; and on those other questions in regard to which he can at best express only doubts and difficulties, he has been able to define the issues with a definiteness and clarity that is most helpful. He has also been able, as have several of the other contributors, to make very enlightening use of supplementary comments received directly from Whitehead in the course of his teaching or in private discussions. To Lowe, in collaboration with R. C. Baldwin, is also due a remarkably complete Whitehead bibliography (inclusive of "selected reviews"), compiled despite the many difficulties occasioned by the War.

Whitehead, in the "Autobiographical Notes", after an account of his schooling in "classics, interspersed with mathematics" at Sherborne—the classics, he remarks, were well taught—tells of his life in Cambridge. "During my whole undergraduate period at Trinity, all my lectures were on mathematics, pure and applied. I never went inside another lecture room". But the lectures, he adds, were only one side of his education. "The missing portions were supplied by incessant conversation, with our friends, undergraduates, or members of staff. . . . We discussed everything—politics, religion, philosophy, literature—with a bias towards literature. This experience led to a large amount of miscellaneous reading. For example, by the time that I gained my fellowship in 1885 I nearly knew by heart parts of Kant's *Critique of Pure Reason*. Now I have forgotten it, because I was early disenchanted. I have never been able to read Hegel: I initiated my attempt by studying some remarks of his on mathematics which struck me as complete nonsense. It was foolish of me, but I am not writing to explain my good sense".

These sidelights on his early studies go far in explaining what would otherwise be so difficult to understand: the seeming abruptness of Whitehead's transition from a philosophy of science to metaphysics "Whitehead is very English. He is also very Whiteheadean: he could not have done otherwise. What might, by critics at least, be called the contribution to his philosophy that comes from his *amateur* side, has been a subject of meditation for decades; this appears plainly in every account of his life's activities". This is the central theme of Lowe's historical and critical account of Whitehead's development. He distinguishes in it three main periods: a first devoted to mathematical and logical investigations (up to 1914), a second to the philosophy of natural science (1914–24), and a third to metaphysics and the historical role of metaphysical ideas in civilization (1925 onwards). In the second period Whitehead has been chiefly concerned to achieve the integral inclusion of geometry in the world of change, and to do so without yielding to the anti-space bias betrayed by Bergson. As Lowe recognizes, what especially calls for explanatory comment, in regard to these second and third periods, is: (1) Whitehead's gradual divergence from the 'class-theory' of perceptual objects (as held by him in common with Russell) and adoption in its place of a 'control-theory' of physical objects; and (2) Whitehead's ever-increasing preoccupation with metaphysical issues, and the tendencies seemingly (but not in actual fact) anti-intellectualist, which accompany and condition it.

Already in the papers published between 1915 and 1917, as Lowe points out (p. 61) "un-Russellian, un-Humean, un-positivistic traits" are discernible. But these traits, and the direction in which they were leading Whitehead, though partially disclosed in the "Principles of Natural Knowledge" (notably in its superb opening chapter) and in the "Concept of Nature", first became clear only on the publication of "Science and the Modern World" (1925)—a work the teaching of which alienated so many of his older associates, while attracting the attention of a new and wider audience. Even so, the clearness is indeed relative; the middle, metaphysical, chapters were found barely understandable even by some of the best instructed of his readers, and had to await, for their decipherment, the more detailed and in certain important respects modified, formulation of them in his subsequent writings. The continuing ferment in his ideas, as Lowe recognizes, has "interfered with their bottling", and as Lowe justly adds, "this remark applies in some degree to every part of Whitehead's works". Fundamental in Whitehead's defence of metaphysics, in what he considers to be its proper role, namely, as a constant critic of partial formulations, is his attitude of opposition to "the false neatness of *abstract* intellectualism", that is, to the assumption that there is an already existing stock of concepts, at once general and precise, on hand for use by scientists and philosophers. He is not intending to deny the necessity of abstraction for the purposes of science, but he is anxious to insist that just for this reason metaphysics cannot be dispensed with if "a right adjustment of abstractions" is to be made. "This is missed by the critics who think that Whitehead denies the principles of scientific method when he turns philosopher. Far from making general war on acts of abstraction, he insists that such acts are indispensable to the advance of thought. What he objects to is a bigoted insistence that only fools investigate the totality from which the abstraction has been made. If philosophers keep to the same abstractions that sciences make, they are scientists in disguise, or possibly pseudo-scientists who happen to earn their living by teaching philosophy. If a man of Whitehead's ability delves behind the abstractions made by particular sciences, it becomes possible for philosophy to 'point out fields for research'. Whitehead thinks that the *development* of those fields must be assigned to specialists".

The other seventeen papers cover all the main aspects of Whitehead's teaching. Joseph Needham treats of "A Biologist's View of Whitehead's Philosophy", and A. D. Ritchie of "Whitehead's Defence of Speculative Reason". The other essays are all by American contributors, including the veteran John Dewey. The average maintained is extraordinarily high, but I may specially mention the paper on "Whitehead and the Method of Speculative Philosophy" by A. E. Murphy and the paper treating of "Whitehead on Mind and Nature" by W. E. Hocking, because of their consistently critical character and of their dealing with really decisive issues. Hocking's attitude is summed up in the very apt comment—"Whitehead's construction springs from a striking freshness of impression achieved against the pressure of a 'learned tradition' which it is one of his pleasantries to put in its place . . . giving rather like an era than a single individual a flood of impulse and a gallery of inchoate conceptual forms. It is a human gift to be able to acquire naïveté; it is what Lao Tze called 'returning to the root': to do so to this extent is, in my judgment, as important a deed as to set up an impeccable list of primitive notions".

N. Kemp Smith.

SOCIAL REPORTING

An Inquiry into British War Production

Part 1: People in Production. An Advertising Service Guild Report prepared by Mass-Observation. (*Bulletin of the Advertising Service Guild*, Change No. 3.) Pp. 410. (London: John Murray, 1942.) 10*s*. net.

THIS report shows clearly that Mass-Observation should be considered as a challenge to journalism rather than to the social sciences. What it offers is a comprehensive description of present-day industrial life in much of its concrete detail. Considered as a scientific study, its superficiality and subjectivity could not be excused on the ground of its extensive range. As a kind of expanded reporting, on the other hand, it develops one of the suggested functions of journalism much beyond what the Press has so far achieved.

The chief method employed was that of interviewing people in all grades of war industry, including the management, the foremen, skilled and unskilled workers, trade unionists, and Civil servants in the Supply Ministries. News items from the Press, anecdotes, and reports from diarists working for Mass-Observation supplement these interviews; now and again the numerical results of a canvass of opinion are included, though no claim is made to the validity of bigger surveys such as the Gallup polls. The topics studied include most of those which crop up in everyday discussions on the use of man-power: hours of work, wages, absenteeism, shopping, billeting of imported workers, sickness, discipline and the Essential Work Order, suspicion as to the profit motive of employers, the outlook and prospects of women workers, the worker's difficulty in realizing the value of his particular job in the war effort, and so forth. Emerging from the survey of most of these problems is the evident need for everybody to understand more fully what other people are doing and the conditions of their work. The Fighting Services, the Supply Ministries, management, foremen and workers all need to know more about each other. Extensive reporting of the kind offered here is one means of fulfilling the need.

Minor defects, such as an occasionally patronizing manner and a seemingly compulsive need to aim pinpricks at those in authority (especially academic authority), are of small account compared with the possibilities of this developing technique. An unsolved problem in this type of reporting is the form in which it should be published. The present report is inordinately discursive and tedious to read. Crisper writing and much briefer comment and interpretation would help. But some form of serializing would be a still greater advantage; a cumulative picture of present-day conditions, built up week by week and continuously modified, would be assimilated more effectively than an occasional report of 200,000 words.

Though not in itself a scientific study, the report shows, as good journalism should, the relevance of current scientific ideas to its observations. The findings of industrial psychologists since the War of 1914–18 are the active ingredients, the leaven in the mass. It is a tribute to the Industrial Health Research Board, the National Institute of Industrial Psychology, and Elton Mayo and his American co-workers, that practically every interpretation and suggestion in this report is derived from the work they have already done. Not all the relevant contributions of industrial psychology are used, however. In particular, our knowledge of the psycho-neuroses in industry, which would have illuminated some of the material presented here, is not drawn upon.

The practical implication of the report is, not unexpectedly, that the human factor in the war industries presents sharp challenges at many points, and that the available resources of the social sciences have not been mobilized to meet them. The author is perhaps too prone to believe that, in his own words, "*Something* is seriously wrong somewhere." What the report shows is quite different; namely, that countless relatively small mistakes are being made everywhere, an ordinary state of human affairs. The difference is important, since the first point of view invites the facile deduction that *something* (usually something political) would put everything right, a conclusion which experience in the applied social sciences does not encourage.

CONFESSIONS OF A CHEMIST

Souvenirs et travaux d'un chimiste

Par Amé Pictet. Pp. 228. (Neuchâtel : Les Editions de la Baconnière, 1941.) 9 francs.

THE posthumous appearance of this autobiography of Amé Pictet, written without any directions as to its publication and, to judge from its outspoken nature, clearly intended for an intimate family circle and friends, is a noteworthy event and a fitting complement to the many appreciative notices of the man which have appeared since his death. Of the appropriateness of the decision of those who facilitated the appearance in print of what, in the minds of many, will be regarded as an interesting historical gem, there can be little question. All chemists, old and young, will profit by a perusal of these frank pages.

Pictet was a great organic chemist who belonged to the nineteenth and twentieth centuries and to the borderland of France and Germany. As a Swiss he received his early education in his own country, but his mature chemical education was completed by three years sojourn in Germany, at Dresden under Schmitt, where he was contemporary with Hantzsch, Curtius and Berlinerblau, and at Bonn under Kekulé and Anschütz. He also spent a short time in Wurtz's laboratory in Paris, where he made the acquaintance of Friedel, Grimaux and Lecoq de Boisbaudran.

Pictet's habit of keeping a diary which he began as a youth, and his craze for documentation, both of which he kept up until his death, have left us a priceless record of the impressions which the events of his life made upon him at the time of their occurrence. It is this candid intimate touch which is such a valuable feature of the work before us. Naturally Swiss chemistry, the Ecole de Chimie and the University of Geneva loom large in its pages, but not obtrusively so. Of his childhood and boyhood days with his parents, aunts and uncles, we are told just what one might have expected to find in an educated late-Victorian English family; the excursions of the female members of the family into phrenology and other pseudo-sciences added to his education but not to his beliefs. Throughout his career, his hopes and fears, his successes and failures, the effect of his discourses on his audiences and on himself are all faithfully and refreshingly recorded. One might have thought that his German training would have given Pictet a bias towards German science, but in these pages an undercurrent frequently comes to the surface, making it clear that he was sensitive to the existence of the unhealthy atmosphere in Franco-German relationship extending even to things scientific, and he states clearly that his leanings are towards the French outlook on science. In his diary Pictet records, during his studies at Dresden, his surprise that the Germans should ignore the discoveries made in France, but is happy to see that the same does not apply to Swiss discoveries, and he naïvely adds: "ce n'est que l'attention des Allemands qu'il importe de s'attirer dans le domaine scientifique."

Of his predecessor in the chair of chemistry at Geneva, Graebe, and of Kekulé, several characteristic anecdotes are recorded. Kekulé, interviewing a young French student in his study, asked him if he knew German, and on receiving a negative reply, impressed on the Frenchman that to practise chemistry it is absolutely essential that one should know German. Graebe, on his retirement, went to live at Frankfort, where Pictet called upon him in his old age. After failing at first to recognize his former colleague, Graebe gradually recovered himself and asked: "What are you still doing in organic chemistry? It's a science which is exhausted."

One of the attractive features of this little volume is Pictet's review of his own researches. The methods he employed were all simple; pyrogenic distillations figure largely, and all his researches have a thread of continuity running through them. His introduction to heterocyclic chemistry and alkaloidal chemistry was more or less accidental. One day at Bonn he was passing a bookshop when he saw a brochure of Königs' open at an article on pyridine, with its proposed formula portrayed. The analogy with benzene so struck Pictet that he resolved to devote his career to this new class of aromatic heterocyclic compounds. This led him into alkaloidal chemistry, and he seems to have been the first to write a book on alkaloids. Its success led to a demand for its translation into English and German—the fate of subsequent German editions must be left to the reader to discover for himself. On the synthesis of nicotine Pictet spent eight years, and he recalls that his views on the genesis of the alkaloids in plants, from protein breakdown products, came to him in a flash when chatting with his assistant Rotschy so early as 1904. His subsequent experiment on the distillation of coal in a vacuum was prompted by a desire to find 'fossilized alkaloids', and it was but a step to subject vegetable substances, which might have given rise to coal, to pyrogenic distillation under reduced pressure. The distillation of cellulose gave him lævoglucosan, and this was naturally followed by the distillation of the sugars.

Organic chemists who are familiar with the history of organic syntheses in the past twenty years will naturally turn to Pictet's own account of the synthesis of berberine, which he published with Gams, and of sucrose, published with Vogel. Both these are discussed and the failures of others to confirm them are fully recognized. He seems to have become reconciled to the incorrectness of the berberine synthesis, but the failure of numerous workers to confirm the synthesis of sucrose was a bitter blow, which threatened to undermine his health. Even to the last he never gave up hope that some one, some day, would rediscover the conditions which lead to a successful synthesis, a hope which he did not live to see fulfilled.

HAROLD KING.

CAN WE ANALYSE OURSELVES?

A Practical Method of Self-Analysis

Enabling Anyone to become Deeply Psycho-Analyzed without a Personal Analyst. By Dr. E. Pickworth Farrow. Pp. xv+154. (London: George Allen and Unwin, Ltd., 1942.) 6*s*. net.

THE author of this book, a doctor of science, sought analysis both as a means of cure for his emotional difficulties and as a scientific experiment. After two hundred hours of work under two analysts, with whom he got at cross purposes, he came upon a method of self-analysis, a writing down of his own free associations, which enabled him to recover early memories—potent in causing his difficulties—the recovery of which brought decidedly beneficial results. This experience he now offers as an encouragement to others to do likewise.

He anticipates and answers some possible objections, but the success of the would-be self-analyser may not be so certain as the author hopes, even with full devotion of time and patience to the effort. Individuals vary greatly in their ability to produce free associations and to recognize the meanings of their own symbolisms. The reviewer knows of two cases in which, after a short experience with an analyst, the analysand was able to carry on in the way here described and bring to light important episodes with an appreciation of their emotional value; both subjects were trained in scientific method and one of them started analysis full of scepticism. But there are many people who lack this ability, even in the presence of an urgent need for the relief of symptoms, and are likely to fail at self-analysis. The author seems to credit mankind in general with his own capabilities, as if someone with a natural bent for mathematics should assume that we all have powers in that direction equal to his own. This tendency to picture others as like himself runs through the book. His own crucial memories are concerned with slaps and blows in infancy and with a severe castration threat which, when revived, produced in his adult mind a state of worry and fright "worse than in the worst nightmare", followed, however, by a great improvement in health and a different view of life. These two complexes are the chief, almost the only, findings of his analysis.

A failure to revive elements apart from these physical hurts or threats is perhaps responsible for a passage that calls for comment. His admonitions as to the ill-effects of slaps and blows and castration threats are useful and necessary, but those in charge of small boys guilty of exhibitionism are to be instructed that the child is to be repeatedly told that *this is very naughty* and that he must not do it, and if this fails the fact is to be reported to the parents. It would be less dangerous and more in accord with truth to say that people *think* it is very naughty, for the full weight of our irrational sex taboo, with the terrible dread of an unknown penalty wrapped in it, is thrust upon the child in that italicized sentence. The taboo exists and we all, young and old, must adapt to it; but those able to explain it to a child find it can be accepted and understood for what it is. In its primitive and unquestioned form it strengthens the unconscious guilt that underlies so much neurotic trouble and it sends many an adult to the consulting-room of the psychotherapist.

The author goes on to indicate his orthodox adult attitude towards infantile sexuality when, instead of the castration threat, he advocates moderate slapping on the buttocks as conducing to the subsequent mental health and stability of the young exhibitionist! Another gap in his analysis concerns the transference—the emotional attitude, positive or negative, towards the analyst—that enables the subject to recapture and work out his infantile emotions. The author frankly admits his non-recognition of this situation; perhaps, if he had accepted the invitation of his second analyst to curse him freely instead of breaking off the analysis, he might have recognized the importance of the transference and its usefulness as an emotional solvent.

In spite of these defects this account of the results of analysis from the point of view of the analysed is most useful. Analysts generally prefer that their subjects should not read the literature; the author's avoidance of anything but passing reference to matters of theory outside his own experience lessens any such objection in this case; his descriptions are straightforward and he uses few technical terms; and even if his avowed aim may rarely succeed, he has produced a book that could very well be read by anyone who contemplates analysis but is still frightened by the bogies of past controversy.

MILLAIS CULPIN.

SCIENTIFIC AIDS FOR THE LAYMAN

Dictionary of Scientific Terms as used in the Various Sciences

By Surgeon Rear-Admiral C. M. Beadnell. (The Thinker's Library, No. 65.) Second edition revised and with Supplement. Pp. x+232+14. (London: Watts and Co., Ltd., 1942.) 2*s*. net.

The Origin of the Kiss: and other Scientific Diversions

By Surgeon Rear-Admiral C. M. Beadnell. (The Thinker's Library, No. 89.) Pp. x+117. (London: Watts and Co., Ltd., 1942.) 2*s*. net.

ADMIRAL BEADNELL'S "Dictionary of Scientific Terms" was first published four years ago, and was warmly welcomed by high authorities for its comprehensiveness, its accuracy and its utility. A new edition having been called for, the book now appears in a revised and extended form. Its chief appeal is to the layman, whom the author has mainly in view. But the vast domain of science necessitates an increasing degree of specialism, and we have it on the authority of distinguished specialists that this concise dictionary is useful to others besides the layman. The latter, however, in the course of his general reading, wants something more than the ordinary dictionary tells him about hormones and vitamins, about wave-lengths, and about the size and weight not only of protons, electrons and atoms, but also of the earth, the solar system and the Milky

Way. Or he may want facts concerning cosmic rays, dwarf stars, the density of space, the mysteries of life and sex, the fertilization of flowers by snails, bats and birds, and a hundred other topics that come to the eye as one turns the pages of this little book. It is a marvellous florin's worth, and well deserves continued success.

The same author's new book, "The Origin of the Kiss: and other Scientific Diversions", is a still more determined effort to help the layman, but with direct reference to the harassing times in which we live. Mental as well as physical relaxation was never more needed than now. People, says the author in effect, want, and rightly want, to be "taken out of themselves", to find means of "escape". Tales of adventure, detective stories and thrillers all serve this beneficent purpose, but for many people they begin to pall, and a craving is felt for something more sustaining. Here Admiral Beadnell comes to the rescue. He seeks to "arouse interest in the 'brass tacks' of the universe, in the way in which so many of man's inventions, not excluding guns and projectiles, camouflage and smoke-clouds, have been forestalled by lower animals, and in the deep significance underlying such apparently trivial matters as kissing, dancing, laughing and flying into a temper". In his twenty chapters the author gives the reader twenty exhilarating excursions into the realms of biology and anthropology, and will probably leave him asking for more.

T. RAYMONT.

CHEMISTRY AND LIGHT

The Chemical Aspects of Light

By E. J. Bowen. Pp. vii+192. (Oxford: Clarendon Press; London: Oxford University Press, 1942.) 12*s.* 6*d.* net.

ALTHOUGH a number of treatises suitable for specialists have recently appeared, there has hitherto been no English text-book on photochemistry and allied subjects which meets the needs of first- and second-year students. Lecturers and students will be grateful to Mr. Bowen for writing a book of which the need has been apparent for so long. In presenting a complete outline of the present state of our knowledge of the interaction of light and matter, the book will also be valuable to the non-specialist and the advanced student, whose sense of perspective is liable to be obscured by detailed study of parts of the subject.

The book opens with an account of the general properties of wave motion and the interaction of electromagnetic waves and matter in classical terms. Chapter 2 deals mainly with practical matters—light sources, units of intensity, etc., and photometry, but includes a short account of black body radiation, with the Stefan and Planck laws, although these are not mentioned by name. This is followed by a comprehensive chapter on the absorption and emission of light. In the main this is a summary of the conclusions of wave mechanics about atomic and molecular energy-levels, transition probabilities and molecular structure. Features of this chapter are the admirable description of the photochemistry of hydrogen, oxygen, chlorine and hydrogen iodide in terms of the familiar potential energy diagrams, and the sections on light absorption by polyatomic molecules, and condensed states. Chapter 4 discusses the important question as to what is the fate of light energy absorbed by a molecule. External and internal deactivation are elegantly explained, and there are discussions of the nature of collisional processes, fluorescence and resonance radiation, and the Raman effect.

In my opinion the arrangement of the book would have been improved if this had been followed at once with Chapters 6 (photochemical reactions) and 11 (chemiluminescence), instead of the chapter on luminescence of solids. The section on photochemical reactions includes practical details, and an account of the collision and transition state theories of reaction, relevant to the discussion of secondary reactions. It is rather surprising that no reference is made, either in this or earlier chapters, to Einstein's law of photochemical equivalence, which was of fundamental importance in the understanding of the process of light absorption. The author points out the uncertainties of bond energies in polyatomic molecules; it might have been mentioned that the carbon arc method is not the only one available for determining the heat of sublimation of carbon. Examples of photoreactions given include the H_2—Br_2, H_2—O_2 reactions, and the photodissociation of NH_3 and the carbonyl compounds.

The remaining chapters of the book give interesting accounts of subjects which do not appear to have been collected together before: photosynthesis in plants, the photographic process, the reactions of the eye to light, and photo cells. In addition, there are appendixes on the preparation of light filters for isolation of lines of discharge lamps, the practical determination of quantum efficiency and the preparation of phosphors. The collected data on light filters should prove extremely useful to the practical photochemist. References to summaries of earlier work are also given.

It will be seen that Mr. Bowen has compressed an enormous amount of material into 186 pages. Throughout the treatment is descriptive and non-mathematical, and maintains a nice balance between theory and practice.

C. H. BAMFORD.

A BOOK OF VISIONS

Primitive Scenes and Festivals

By Sacheverell Sitwell. Pp. xii+283+16 plates. (London: Faber and Faber, Ltd., 1942.) 21*s.* net.

IF any reader should take this for a book of anthropology or archæology, aiming at completeness of treatment and full references to authorities, and feel himself rather upset by the general discursiveness of the whole, the author is not to blame. He tells us very plainly that he writes of what he has studied "with the eyes of the poet or the artist;" the matter of the book is "a subject for a composition, to be judged by intrinsic, not by literal truth". We have in fact a book in which a poet has set down the reactions he has had from his reading and one suspects from his travels, and the reader has only to ask himself if this aim of beauty has been achieved. The appeal is personal: to me it seems that Mr. Sitwell has here scored a fresh success in this very individual kind of writing which he had tried in several other of his books: the series, I think, began with "The Gothick North" in 1929. These "Primitive Scenes and Festivals" are culled over the widest range possible: in time from the days of Stonehenge to the present; in space we are led by our guide from our own islands to Greece and North

America, from the Pacific to many parts of Europe, and all this in less than three hundred pages. The result is a series of highly coloured descriptive reveries, only to be judged by the pleasure felt by the reader in the author's artistic integrity, for his own expression "intrinsic truth" seems to mean nothing very different from this. So Pater summed up his chapter on Lacedæmon: 'Another day-dream,' you may say, about those obscure ancient people, though he claimed, as I think Mr. Sitwell might well do, that his dream followed naturally on the facts as we are able to know them.

I have found the book stirring and delightful: even over pages where the reader is likely to feel a little bewildered, he is carried forward by the poetical intensity of the author's style. Here I am thinking mostly of Book I: "Landscape of the Megaliths"; to get the best of these out-of-door scenes one should read the chapter right through, and then turn to Blake's illustrations to the "Pastorals of Virgil". If this style of writing, which Mr. Sitwell has made so much his own, does sometimes seem strained—and almost to breaking point—it is only when he chooses a subject which fails to inspire, if not the writer, yet the reader. It is difficult to follow the melody, in fact not to skip, when one is confronted by pages and pages on the markings of fancy pigeons. Yet a very similar piece in "The Dance of the Quick and the Dead", devoted to the varieties of Auricula and Polyanthus cultivated by miners and weavers in Lancashire, has a most touching charm: the flight is shorter, and the human interest is much greater; and after all, these fancy pigeons are such monstrous objects.

To dwell a little on what one thinks the best chapters is a pleasure which could be prolonged at will. I was most struck by the account of the Oracle of Dodona, even though it is the doves which are made the occasion of the dissertation on fancy pigeons. No page in the book is more exciting than the description of the beating of the cauldrons to make them ring, as they hang from the trees of the wood. Mr. Sitwell artfully conceals his learning, and how far he has studied the works of Sir James Frazer and Dr. A. B. Cook I do not know, but I find one curious point in which the poet and the scholar have come very close to one another: it is on the word "Dodona". Mr. Sitwell speaks of "the dark feminity" of the name; Dr. Cook has a surmise that it is in some way a reduplicated form connected with "Demeter". The whole description of the place is as evocative of something very distant as the Homeric line: "O King Zeus, of the Pelasgians, at Dodona, dwelling afar." So remote is the oracular valley that it must always be a long ride to Dodona.

There is a terrifying account of the human sacrifices on the stepped pyramid, the Great Teocalli, in Mexico: Mr. Sitwell has a taste for the grim. He shows us the executioner priests living on the top of their pyramid; never coming down except to snatch their victims as they ascend the winding way; exposed to all weathers in a kind of vultures' eyrie of blood and filth. Though nothing is spared, the passage is justified by its wider outlook, but it does remind us of the account of the prison system in "The Dance of the Quick and the Dead", which for sheer dreadfulness can scarcely be read without the pains of a claustrophobic nightmare. In a happier vein is the chapter on the Areöis, the Sea Gypsies, who, like 'playboys' of the Pacific, used to go in their canoes from island to island, entertaining the people with their songs and dances. They were a part of that old, childishly beautiful, if sometimes cruel, world of the islands before the traders and missionaries came to make us ashamed of what we have done to these unhappy children. By our acts, through the greed of the whites, they have, as Mr. Sitwell puts it, "fallen out of an earthly paradise into a Sunday slum, the conch shell made silent by the harmonium". "We could have wished it was but an interlude, a day and a night in prison; but what it touched has been destroyed for ever. It has been the hand of death: and, in life, it is better not to think of that." The poet can only turn his back; sadly.

Book VII is called "The Festival at Nola." It is a description of the feast of St. Paulinus, when *guglie*, "lilies", tall baroque obelisks decorated in all sorts of ways, are carried through the streets. Mr. Sitwell introduces speculations that this festival originated in the rites of Adonis, and certainly the dancer who faints and pretends to die and is then suddenly revived is very remarkable. But here, and perhaps here alone in the book, we ought to have been told a good deal more if such speculations are to be fruitful. We must take into consideration the fact that these processional towers or obelisks are not peculiar to Nola: they are to be found at Gubbio, at Viterbo, and at several other places in Italy. Any quantity of learning about them is to be found in Dr. Thomas Ashby's book, "Some Italian Scenes and Festivals". It may be admitted, however, that these ideas about Adonis are just as good as the old suggestion that the towers at Gubbio are a survival of the ritual described on the Iguvine tablets. To me the *guglie* seem to be simply triumphal cars of the same family as the *carroccio* at Florence, only enormously developed in the vertical direction to suit the narrow winding streets of old Italian towns.

We are given sixteen good and well-chosen illustrations; the only one in the faintest degree hackneyed is the picture of the Lion Gate at Mycenæ, and perhaps this is not so familiar to everyone as it is to travellers in Greece. What could be more delightful than the drawings from Catlin? The Crow Indians on horseback, and the delicate picture of the Indian chief, Mahtotohpa, of whose death we are given so tragic an account: all his tribe were dead of smallpox; he alone had been strong enough to recover; then, left all alone, he starved himself to death. But is there not in fact a certain incongruity in illustrating a book like this at all? When we are so much in the hands of the writer, we do not greatly care to see what lies behind and below; when we are, so to say, in the palace of art, we may well be content to let the foundations be hidden. To ask for illustrations is rather too much like demanding references to authorities. Perhaps the true illustrator would be a double of Mr. Sitwell himself, but armed with a brush instead of a pen.

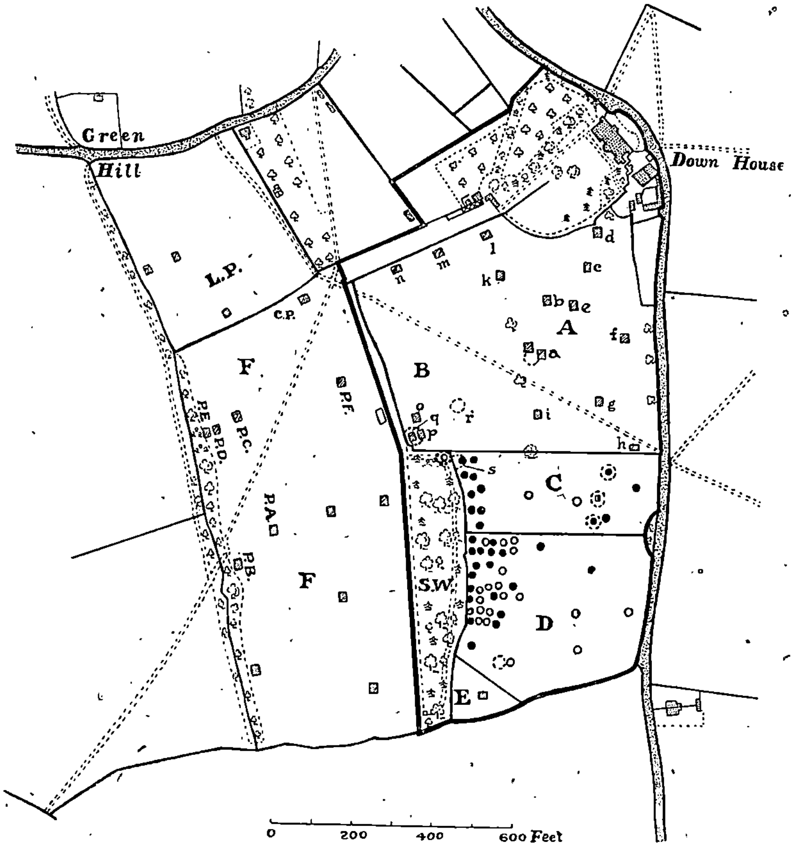
In this review I have tried to give some idea of the scope and intention, as I see them, of this book, and I am very far from having exhausted the subject: other readers would quite likely make quite other choices, after their walk, if one may use the metaphor, through the gallery which Mr. Sitwell, an artist of the greatest virtuosity, has hung with his latest pictures, with subjects found this time in an earlier and simpler world. I can only recommend people who care for imaginative writing to get this book, and allow the author to show them what he has described in the world of primitive humanity, whatever be its date, and how it can be interpreted by a poet in terms of beauty.

R. M. DAWKINS.

A POSTSCRIPT TO DARWIN'S "FORMATION OF VEGETABLE MOULD THROUGH THE ACTION OF WORMS"

By SIR ARTHUR KEITH, F.R.S.

ON December 20, 1842, three months after taking up residence at Downe, Darwin spread "a quantity of broken chalk over a part of a field near my house" with a view "of observing at some future period to what depth it would become buried". Twenty-nine years later—1871—he had a trench dug across this part of the field; "a line of white nodules could be traced on both sides of the trench at a depth of 7 inches from the surface. . . . Another part of this same field was mossy and it was thought that sifted coal cinders would improve the pasture, a thick layer was spread over this part either in 1842 or 1843, and another layer some years afterwards". In 1871 a trench was dug revealing a line of cinders at a depth of 7 inches and another parallel line at 5½ inches". (These citations are taken from pp. 139, 141 of the 1881 edition of Darwin's book, "The Formation of Vegetable Mould through the Action of Worms"; in the remainder of this article, I shall cite merely the page number. Darwin began observations on the formation of mould in 1837 while staying at Maer, Staffs, the home of Josiah Wedgwood—his uncle (and future father-in-law). His observations of that period were communicated to the Geological Society of London on November 1, 1837.)



A PLAN OF DARWIN'S MEADOWS WITH SITES AT WHICH SOUNDINGS WERE MADE.

A B. North meadow; the sites of trenches are numbered *a–r*.

C. Middle meadow; *D*. South meadow or cricket field. The sites at which chalk was found are marked by black circles, those in which chalk was absent by open circles.

E. "Little Canada".

SW. Sandwalk.

FF. Great Pucklands. *LP*. Little Pucklands.

CP. Chicory patch.

Other explanations in text.

Anyone who is interested in Darwin's experiment and who wishes to ascertain what has become of his line of chalk nodules and of sifted coal cinders after the lapse of a century is met at the threshold of his inquiries by the fact that Darwin gives no indication of the part of the field on which chalk and cinders were spread, nor are we certain of how much he included under the term 'field'. At present the twelve acres (Ordnance Survey gives 14·4 as the acreage of Darwin's field) of pasture land which was purchased with Down House* is divided into three meadows (see accompanying figure)—a north meadow (*AB*) near Down House, a small middle meadow (*C*) and a distant or south meadow (*D*) now used as a cricket field. The sandwalk (*SW*) which bounds these meadows on the west was acquired from Sir John Lubbock at a later date. The pasture land was so divided during Darwin's lifetime, but when he speaks of a "field", apparently he does not refer to a meadow but to the whole of the twelve acres. Major Leonard Darwin agrees in this interpretation and cites the following passage from "Life and Letters of Charles Darwin" written by his brother Francis: "Eighteen acres of land were sold with the house, of which 12 acres on the south side of the house form a pleasant field" (vol. 1, p. 321). In writing to his sister Susan in 1845, Darwin mentions a mound which hid "part of the field". Yet on p. 298 of his work on the formation of mould we have this passage: "It may be well to recall here the case of fragments of chalk buried beneath worm-castings on one of my fields."

Even if we agree that Darwin included all twelve acres under the term "my field", we have still to discover the parts on which he spread chalk in one case and sifted cinders in another. Major Leonard Darwin, on my appealing to him, thought the most likely area to receive an application of cinders would be that part of the north field (*A*) lying adjacent to the house—the north-east corner—and it is in this area that my trenches reveal the cinder-layer at its thickest; but cinders, fragments of unburned coal, of brick and of tile were found throughout the twelve acres—all at the same uniform depths. Chalk was found nowhere in fields *A*, *B*, with the exception of one small pocket to be mentioned later. It was found in that part of the cricket field lying by the side of the sandwalk and in the adjacent field *C*—an area less than an acre in extent. Major Darwin had no direct knowledge of the site when I informed him of my discovery of chalk nodules in the cricket field; he wrote: "Memory plays me many tricks, but I now have an idea or memory that chalk was put on the field near the sandwalk because it was felt it would look ugly near the house."

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* "Downe" is the spelling given by the Ordinance Survey for parish and village; "Down" is the spelling used by the Darwins for their home.

Before proceeding to describe what was revealed by my trial trenches in Darwin's field let me turn for a moment to an eleven-acre field which bounds the Darwinian property on the west (*FF*). It was in the first stage of becoming pasture land when Darwin arrived in 1842, having been last ploughed in 1841, and has remained in pasture ever since. The larger part of this field is on the flat upland, but its western part slopes rapidly down over the brow of an adjacent valley or coombe. "The field," writes Darwin, "was always called by my sons *the stony field*. When they ran down the slope the stones clattered together. I remember doubting whether I should live to see these larger flints covered with vegetable mould and turf. But the smaller stones disappeared before many years elapsed, as did every one of the larger ones after a time; so that after thirty years (1871) a horse could gallop over the compact turf from one end of the field to the other and not strike a single stone with his shoes."

The local name for the stony field is Great Pucklands. In 1931, three years after he had purchased Darwin's home and grounds, repaired and endowed them and transferred them as a trust to the British Association, Sir Buckston Browne bought Great Pucklands and the adjacent Little Pucklands and gave them to the Royal College of Surgeons of England as a site for a station or farm for surgical research, which was also endowed by his munificence. Thus it was I came to make my home in Downe and to make an acquaintance with Darwin's "stony field" and ultimately to wage war upon its weeds.

At the beginning of 1941, Dr. Colbeck and I, being in need of winter fodder for the College guinea pigs, ploughed half an acre of Great Pucklands to a depth of six inches and sowed out in chicory and kale. In the spring of the present year (1942) the kale having been uprooted and the chicory blades having died down, this half-acre presented the stony appearance that had met Darwin's eye over the whole of Great Pucklands a century before. I marked out half-a-square yard (36 in. by 18 in.) between two of the chicory rows; loose flints on the surface numbered 137, weighing collectively 14 lb.; I sifted the soil underneath down to a depth of 8 in. and obtained more than four hundred flints (varying in weight from 15 gm. to 450 gm.) and weighing collectively 39 lb. Thus in every square yard down to a depth of 8 in. there were 106 lb. of flints, amounting in round numbers to 230 tons per acre. The re-assortment of soil and flints, effected by worms in Great Pucklands during the past century was revealed by sections made in various parts of the field both on the level and on the slope.

Let me first compare the section which Darwin made in 1871 with one I have just dug at or near Darwin's site (*PA*). His section revealed (p. 144) an upper stratum, rather less than three inches in thickness, of stone-free mould (including turf) and a lower stratum which he described as "a coarse clayey earth full of flints". While the evidence from his own fields indicated that worms threw up mould at the rate of an inch in five years, here the evidence was of a much slower rate, namely, an inch in twelve years. My section showed the same thickness of stone-free mould as did Darwin's. In my section it varied from 2·5 to 3 in.; under the mould came a "stony stratum" 5 in. in thickness and containing more than one thousand flints, similar in size to those met with in the chicory patch, the stones being held together by Darwin's "coarse clayey earth". In all sections of our turf-land over the chalk this "stony stratum" serves as a bench-mark, particularly its uppermost stones, which form a kind of pavement. Under the stony stratum, beginning at a depth of 8 in., came weathered clay with numerous flints, which I dug to a depth of 15 in. from the surface without finding any object foreign to the clay.

Thus it will be seen that in the seventy-one years which have come and gone since Darwin made his record the surface strata on the declivity of Great Pucklands have remained in a state of equilibrium. Some of the factors which help to maintain a stationary position in spite of worm action, or rather because of it, are suggested by other sections I made along the valley-set part of Pucklands. Some thirty yards farther down the slope than the trench just described (*P B*), the field ends on the side of the valley in a steep bank, occupied by a belt of ancient beech trees. As the bank is approached the land becomes nearly level. Rank grass grows here which every autumn becomes cluttered with brown beech leaves—food for the worms. Here I expected to find the soil deep, and that I think would have been Darwin's expectation. To my surprise my spade struck the stony stratum before it was three inches into the turf. The mould was intensely black in colour, very friable, and was 2½–3 in. in thickness. The underlying stony stratum was 6 in. in thickness and, again to my surprise, the clay under the stony stratum was white with chalk nodules, the chalk being 3 in. under the stony stratum and continuing to a depth of 14 in.—beyond which I did not dig. The earth between the flints of the stony stratum was very black and had in it much decayed fibrous material; there was ample evidence of worm action in the stony stratum and in the overlying mould but none in the chalk. Darwin must have known that a stratum of chalk serves as an efficient worm barrier. Under the walk of his kitchen garden there are 8 in. of chalk, which although laid down in 1845, still keeps worms from reaching the gravelled surface. When he laid down the "sandwalk" he used chalk as a foundation. So with the trench just described; the underlying chalk seems to limit the traffic of worms in a downward direction. I ought not to have been surprised at finding chalk in the depth of this trench, for along the side of the coombe, at the level of the beech bank, is a series of disused chalk pits.

Other trenches dug into the more level ground, above the beech bank and about a hundred yards to the west of the one just described (*PC*, *PD*, *PE*), throw light upon the manner in which the stony stratum, in a long-established pasture, is maintained at a fairly constant level. The trench I am now to describe lies in the middle of the zone which becomes so thickly covered with beech leaves every autumn and from which they vanish in early summer. There were ample signs of worm casts at the site; I counted eight fresh ones in an area of two square feet and as I cut the turf counted eight worms. The surface mould was black as soot but only 2½–3 in. in depth. The stony stratum, 4 in. in thickness, contained black sandy earth with black vegetable fibre; below the stony stratum came a fine sandy loam with a line of chalk nodules in it, three inches below the stony stratum. While the mould was black the underlying loam was snuff-coloured, so that any mixing of the black mould with the underlying loam was easily detected. It was clear that the worms were conducting a double-way traffic; the black-coloured mould carried into the deeper loam seemed to me to exceed the amount of loam added to the black soil. If the loam brought above the stony stratum by worms is equal to the mould which they and the rain carry through the stony stratum, then a condition of equilibrium would be attained.

So far I have been dealing with sections made on the sloping parts of Great Pucklands; but before returning to Darwin's own field it will be helpful to examine a typical section made through the turf on the flat area of Pucklands. Here, as in Darwin's field, the surface soil is separated from the underlying chalk by a red clay varying from 8 to 14 ft. in thickness and containing numerous flints. The section I shall describe is one made about 120 yards to the east and south of the chicory patch (*P F*). In my earlier trenches I first removed the turf with 2 in. of soil from an area measuring 36 in. by 18 in. (half a square yard) and then deepened this area, 2 in. at a time, until a depth of 14 in. was reached. The material from each 2-in. level was sifted, the contents of my sieve being noted for each level—flints, pebbles, brick, tile, cinder, charcoal, iron, etc. I took my levels from a straight edge laid across the trench resting for 6 in. on the more level and shorter turf on each side of the trench.

After a time, finding the soil structure to be uniform throughout the level pasturage of this neighbourhood, I replaced this tedious method by a simpler one which I shall now illustrate in connexion with the trench I am to describe—that to the south-east of the chicory patch (*CP*). My spade, a light one with straight blade, 6 in. wide and 9½ in. in depth, sinks easily through the short turf and grates against the stony stratum at a depth of 4 in. or 4½ in. A little movement of the handle causes the turf, and soil under it, to separate from the stony stratum, where the roots of the herbage end, only the deeper rooted weeds—the dock, thistle, knapweek, etc., penetrating the stony stratum to the subsoil of weathered clay (often sandy) underneath. In the chicory patch the flints were intermingled with the soil; but here the worms have thrown the soil up and permitted flints and all foreign bodies which may happen to have been present in the soil at the time of ploughing, cinders, bits of tile and brick, etc., to subside into the stony stratum. Anything thrown on the turf later will be arrested in its submergence when it reaches the stony stratum. Any foreign body found under the stony stratum was probably *in situ* before the stony stratum came into being. The turf, with the underlying mould, as I have said, separates easily and naturally from the stony stratum. When we turn its deeper surface up to the light, we find the openings of worm burrows, a few of the worms and some of the looser small flints which have come away from the stony stratum with the turf. In this particular trench (*P F*), I was surprised by a complete absence from the deep aspect of the turf of small pebbles, cinders, fragments of brick, etc., which are so abundant at this level in the neighbouring Darwinian fields. The removal of the layer of turf exposes the upper aspect or pavement of the stony stratum—the chief level of worm activity and of mole activity. Worm chambers were noted here but only two polished pebbles; usually there are a dozen of such pebbles, smooth and glistening, apparently from the friction of worm movement. The stony stratum was made up of flints of the same size and number as were loosely strewn through the soil of the chicory patch. I dug to a depth of 14 in. from the surface—that is 5½ in., into the weathered clay under the stony stratum—but found only virgin ground. There was no trace of chalk to be seen.

With the experience of Great Pucklands to fortify us, we are now to make a survey of Darwin's meadows beginning with a triangular enclosure about half an acre in extent known in recent days as "Little Canada" (*E*); it is at the southernmost extremity of Darwin's land, beyond the cricket field. It had been a vegetable garden but twenty years ago it was left at the disposal of Dame Nature, who made it into a wilderness of thorn, blackberry, wild-rose, traveller's joy, with an abundance of thistle and nettle. In January of the present year (1942) with Dr. Howarth's consent, I began its clearance, but after the clearance and before ploughing, made an examination of the soil structure, similar to that made in the chicory patch. In twenty years, worms had covered the larger more superficial flints with a layer of black mould less than half an inch in thickness (1 cm.); between these superficial stones the mould was about 3 cm. thick—perhaps 1½ in. Darwin knew that worm castings accumulate very slowly on the surface of ploughed land but gave no explanation. There is no lack of worms in "Little Canada"; in the loosely knit upper soil they seem to be able to get rid of their castings without actually emerging on the surface—as they have to do when the soil is covered by dense turf.

I dug a trench of the usual size (36 in. by 18 in.) down to a depth of 15 in., sifting each level as I deepened my trench. I found, but not clearly defined, three strata; the uppermost ended at a depth of 2 in., which I shall label *A*; below *A*, came *B*, three inches in thickness (3rd, 4th and 5th inches); and deepest of all *C*, extending from the 5th to the 15th inch. There were two levels or zones at which foreign material had accumulated—namely, in *B* (which represents an initial stage in the formation of a stony stratum); in this there were many fragments of unburned coal, cinders, pieces of brick, fragments of pottery; the second foreign zone was in *C*, namely, between the 8th and 10th inch. At this level in *C* occurred fragments of coal and of charred wood, pieces of brick and seven nodules of chalk (at the 10th inch level). The flints in the upper stratum (*A*) numbered 138, in *B* 353, in *C* 550.

We now enter the "cricket field" in search of the site of Darwin's experiment with chalk chips and bend our steps to that part which adjoins the sandwalk. Here the zone of the field which adjoins the sandwalk, about twenty yards in width, is now, and has been for many years, undermined by moles. On and near their 'heaps', in one particular part, lying near where a gate enters from the sandwalk—towards the north-west corner of the field—there are many fragments of chalk. Chalk does not occur in earth thrown up by moles in any other of Darwin's meadows. My trenches in the bigger field (*A*,*B*) uncovered not a single nodule of chalk; only in a zone adjoining the sandwalk did my trenches reveal chalk with any degree of constancy; and even here there was no certainty; a trench might reveal an abundance and the next trench dug within the chalk area and within a few yards of the first yield not a trace.

The area on which Darwin spread chalk was apparently a zone of the cricket field adjoining the area which later became the sandwalk, about 25 yards in width and extending from one side of the cricket field to the other—about a hundred yards in extent. The chalk zone continues into the adjoining or mid-field, ceasing when the northern boundary of that field is reached. In the sketch map the soundings which yielded chalk are indicated by black circles, those which were free from chalk are indicated by open circles. The trenches which reveal chalk are most thickly grouped on the border of the sandwalk; the chalk area is rather less than an acre in extent. In this area chalk occurs at four levels: (1) on the surface thrown up on mole hills; (2) in the mould at a depth of 3–5 in.; this I regard as chalk which had been thrown on the surface by moles at some time within the last twenty years. It occurred at this level in nine of the fifty-five holes I dug in fields *C D*. The third level at which chalk occurs is that at which Darwin found it in 1871, namely, 7 in. I infer Darwin measured to the deepest point of the chalk level, the nodules thus occupying the whole depth of the 7th inch. Now this level lies invariably within the "stony stratum" which usually begins at 4–4½ in. from the surface and extends to a depth of 8–8½ in., at which level the subsoil of weathered clay or sandy loam begins. In only nine of the fifty-five holes dug was chalk found at the Darwinian level. If the chalk I have found at the 7-in. level is a remnant of Darwin's spreading, as I believe it to be, then there has been no movement since 1871. The fourth chalk-level is 3–4 in. under the stony stratum, embedded as big nodules in the soft clayey-loam, occupying a very definite and regular zone. This was by far the most constant level at which I found chalk. In the thirty-four soundings which yielded chalk in fields *C* and *D* the chalk occurred at this deepest level, namely, 9–12 in. beneath the surface in twenty-five instances.

Does this deep chalk represent a remnant of that spread by Darwin in 1842? I am convinced, for various reasons, that it does not, but had been at the level we now find it long before Darwin's time. Darwin was confident that his field had been in pasture for at least thirty years before he came to Downe—probably, he adds, for "three times thirty years". We may be certain that a stationary stony stratum was already in existence long before 1842. Could the chalk nodules penetrate this stratum and so reach the subsoil? Let me quote Darwin's actual words touching this point (p. 140): "Beneath the line of chalk nodules there was in parts hardly any fine earth free of flints, while in other parts there was a layer, 2½ in. in thickness. In this latter case the mould was altogether 9¼ in. thick; *and in one such spot a nodule of chalk and a smooth flint pebble, both of which must have been left at some former time on the surface, were found at this depth*". I have italicized part of the last sentence, for Darwin, too, was apparently suspicious of the deep chalk as being of his sowing. I have seen 'break throughs' in the stony stratum; they are rare; the stratum is usually intact and the chalk nodules in the subsoil are regular—not haphazard in their disposition. Chalk also occurs outside the 'chalk zone'—in the eastern part of field *C* and in the adjoining part of the cricket field. Here it occurs at the deepest level.

What I have observed in nowise invalidates Darwin's experiment. He spread chalk on the turf and in twenty-nine years found that it had become buried by worm action to a depth of 7 in. Under the dissolving action of rain, of root action and of organic acids in the soil, angular pieces had become reduced to rounded nodules. In the seventy-one years that have come and gone since he examined his line of chalk nodules exposed in section, the solvent action of rain, of root and of soil continued on the chalk nodules and only traces of his experiment are now to be found. But the deep chalk which was *in situ* before the field was last ploughed, perhaps a century before Darwin's day, is protected from these agencies by its depth and still survives as nodules of considerable size (30 mm. by 30 mm. by 20 mm.).

The part of the field which was 'mossy' and over which a thick layer of "sifted coal cinders" was spread, I believe to have been, as Major Darwin suggested, that area of the north meadow (*A*) which lies adjacent to Darwin's house and lawn. Every one of the twenty soundings I made in the north meadow (*A B*) revealed a line of cinders in or near the 6th inch, counting from the surface, but the cinder layer in the area lying towards the house was much richer and thicker than elsewhere.

As already explained I dug my earlier trenches, spit by spit, sifting each as my trench deepened. We may take the results from a trench dug in meadow *A*, within fifty yards of Down House, as representative of the richer area. The vegetable mould, sifted down to a depth of 4½ in. left in my sieve nine small flints, four pebbles, two cinders; the next spit, down to a depth of 6½ in., thus including the upper level of the stony stratum, eighty flints, large and small, forty-eight pebbles, ninety-five cinders (including among these many fragments of uncharred hard coal or anthracite), four fragments of brick and several other foreign bodies; the third spit, down to a depth of 8 in., thus including the rest of the stony stratum, gave 328 flints, forty-four pebbles and only four cinders. Deeper than 8 in. no foreign object was found in this trench, but in others pieces of brick and tile were frequently observed. Indeed it may be said that fragments of brick and tile are to be found everywhere in Darwin's meadows, both in the upper and lower levels.

When, in 1871, Darwin dug a trench he observed "many cinders lay in a line at a depth of 7 inches from the surface". Here, as in the case of his line of chalk nodules, I infer his measurement refers to the deepest point reached by the cinders. In the seventy-one years which have elapsed since Darwin made his sounding, although worms have been throwing up castings every year, the cinder layer has certainly not become deepened in its level. Having subsided, under worm action, to the bottom of the vegetable mould, cinders and all foreign objects become arrested on and between the upper flints of the stony stratum and there remain until they are dissolved by soil agencies. Indeed my data indicate that the thickness of the vegetable mould in Darwin's meadows has diminished to an extent of half an inch, perhaps a whole inch. More has been washed out, or taken out of the soil, than has been returned to it. There has been much and prolonged hard farming.

I was able to verify and extend another of Darwin's observations recorded in the following passage (p. 141): "In another part of this field, which had formerly existed as a separate one" (see *B*) "which it is believed had been pasture land for more than a century, trenches were dug to see how thick the vegetable mould was. By chance the first trench was made at a spot where, at some former period, certainly more than forty years before, a large hole had been filled up with coarse red clay, flints, fragments of chalk and gravel ; and here the fine vegetable mould was from $4\frac{1}{8}$ to $4\frac{3}{8}$ in thickness". In a corner of field *B*, situated at the north end of the sandwalk, there is still to be seen a wide hollow, which, before it was filled up, had perhaps served as a cattle pond (*p.q*). Digging here, where grass grows rank and strong, I found the vegetable mould measured $3\frac{1}{2}$ –$4\frac{1}{2}$ in. ; under it came a thick stratum of flints and at a depth of $8\frac{1}{2}$ in. below the surface, several large blocks of chalk but I failed to find the coarse red clay. This, however, I found in an adjacent hollow of the neighbouring field (*s* in *C*). In this neighbouring site the mould, which is very black, for the hollow is shaded by trees of the sandwalk, measures only 2–3 in. in thickness and showed much evidence of worm activity. The black mould rested directly on a red plastic clay, which yielded to the spade as if it were cheese. In the red clay could be seen long 'test-tubes' or fingers of black mould which worms had carried from the shallow surface layer into the cheesy red-clay. The worm castings were black ; none were red. Thus it will be seen that the vegetable mould covering the sites of two former holes at the northern end of the sandwalk, remain much as they were in Darwin's time. The mould has not increased in the past seventy-one years ; such slight evidence as there is points rather to a diminution in thickness.

Perhaps readers may recall the passage (p. 145) in which Darwin gives an account of a "narrow path running across my lawn, paved in 1842 with small flag-stones set on edge ; but worms threw up many castings and weeds grew thick between them. . . . The path soon became almost covered up, and after several years no trace of it was left". In 1877 Darwin removed the turf and found the path "covered by an inch of fine mould". One would like to know how deep that path now lies in Darwin's lawn but Dr. Howarth and I have 'sounded' and searched for it in vain. But I suspect it is covered by at least 5 in. of mould, for the fork I used in my soundings had prongs of that length.

Summary. I have given in this article an account of the chief facts revealed by digging trenches, some seventy in number, in the fields at Downe, which supplied Darwin with so much of his data for his work on "The Formation of Vegetable Mould through the Action of Worms". The main result is to prove that after a time chalk, cinders or other foreign bodies, when spread on the turf, do not continue to be buried deeper and deeper by worm action, but reach a stationary level. This is due to the fact that, in the fields at Downe, the action of worms is twofold ; they throw up on the surface a stone-free vegetable mould ; they cause flints and all solid objects in the soil to subside into a stony stratum. When objects have reached the stony stratum they remain stationary. When a stone is thrown in a pond it sinks to the bottom and there remains ; it is the same if we cast an object upon permanent turf ; under the action of worms it sinks to the bottom—the stony stratum and there abides. Plentiful remains were found of the cinders spread by Darwin a century ago ; but his chalk chips have almost disappeared. Objects found in the subsoil under the stony stratum are survivals from the period which preceded the last ploughing.

BIOLOGICAL ASSAY OF INSECTICIDAL SPRAYS

By DR. E. A. PARKIN
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MORE than a hundred and fifty different kinds of insects have been found from time to time on stored produce, but only a dozen or so are found often and in dangerous numbers. The control of these insects is a matter of considerable economic importance, more particularly when foodstuffs susceptible to attack by them are kept in store over prolonged periods and wastage must be avoided. The use of insecticidal sprays as a control measure, in warehouses where grain, dried fruits, cacao, etc., are stored, is comparatively simple and, when properly applied, has been shown by experience to be effective, provided the infestation has not been allowed to reach too great proportions. The Pest Infestation Laboratory of the Department of Scientific and Industrial Research is therefore carrying out a study of these insecticidal sprays as one of the chief items in its programme of research on ways of combating infestation of stored produce by insects. Special attention has been given to the development of a method of comparing the killing power of different sprays since it was evident that a comparative test of this kind was essential as the next step in the process of improving insecticidal sprays. The technique of the test which has been successfully worked out at the Pest Infestation Laboratory is described in the second half of this article.

As a control measure spraying has the advantage of being simple and safe to both operator and goods, if done with reasonable care. The chief requirements of an insecticidal spray are that : (1) it should be toxic to as many of the common pests of produce as possible, in the concentrations which can be economically applied ; (2) it should retain that toxicity as long as possible after it has been applied ; (3) it should not be toxic to man ; (4) it should not taint goods to which it may be applied ; and (5) it should not be inflammable. A spray may kill insects by direct contact, by leaving a toxic film on surfaces, or by evaporating to give a poisonous vapour, thus acting as a local fumigant.

The first scientific study of the use of a pyrethrum–oil mixture as a spray for controlling infestation in warehouses was carried out for the Australian Dried Fruits Board by the Department of Zoology and Applied Entomology of the Imperial College of Science and Technology under Prof. J. W. Munro between 1931 and 1938. This is described in two papers by Dr. C. Potter[1]. This work was designed to develop a method of controlling the infestation of dried fruit in warehouses by the moths *Plodia interpunctella* Hb. and *Ephestia elutella* Hb. At first, the technique consisted of filling the warehouse with a finely atomized mist of a mixture of pyrethrum extract in a heavy, highly refined white oil. This process was carried out every evening during the period of emergence of the moths. Although this was found to be effective, it was expensive in labour and materials, involving a lengthy spraying process every day for a period of at least three months. It was found later that the effectiveness of the pyrethrum–oil spray was largely due to the fact that, when it settled, or was sprayed directly on to a surface, it left a film which remained toxic to moths and caterpillars for some days. A concentration of 1·6 per cent weight in volume of pyrethrins I and II was at first used in the mixture, but experiments showed that a concentration of 0·8 per cent was sufficient for these two moths in all stages of their development. The new technique of spraying the walls of the warehouse and the boxes of goods stored in it twice a week from the middle of May until the end of September, was extensively used in London, Liverpool, Glasgow, Manchester and elsewhere and proved effective, while being cheaper and simpler than the technique first used.

This experience naturally led to the use of this spray as a control measure against other insects of stored produce, including the coleopterous pests of grain, flour, etc., which are more resistant to insecticides. It was found by practical use that a spray containing 1·6 per cent total pyrethrins gave a good measure of control, though there was no means of testing accurately the effectiveness of sprays of different concentrations.

This mixture of pyrethrum extract in oil was selected as being the most suitable type of insecticidal spray for warehouse use of which both the constitution and the performance were well known. Attempts to improve it are, however, being made in the light of practical experience of its use and of fundamental biological research on the insect cuticle, now being carried out in the Imperial College of Science and Technology by Dr. Hurst[2]. These attempts are directed towards the search for substitutes for pyrethrum as the toxic principle of the spray, and towards the search for activators which, when added to the simple pyrethrum – oil mixture, will increase its toxicity to insects. Such attempts are prompted both by a desire to improve the sprays themselves, and also to effect economies in the use of pyrethrum, which has to be imported, chiefly from Kenya, at the present time.

If insecticides contain only pyrethrum in the specified oil, the maintenance of a standard of toxicity can be achieved by chemical determination of the pyrethrum content, but to compare the effectiveness of sprays containing activators, or toxic principles other than pyrethrum, with such a simple spray, it is clear that a biological assay is required.

A committee, under the chairmanship of Dr. F. Tattersfield of the Rothamsted Experimental Station, recently considered the specification of a standard spray and the methods of assaying sprays for use against the insects of stored produce. A specification of a standard spray was drawn up by Prof. J. W. Munro (Imperial College of Science and Technology) and Mr. J. C. F. Fryer (Ministry of Agriculture, Plant Pathological Laboratory). This is a mixture of an extract of pyrethrum in heavy oil with a similar heavy oil diluent to give a final concentration of 0·8 per cent (wt./vol.) pyrethrin I, equivalent to a concentration of about 1·6 per cent total pyrethrins. The specific gravity, viscosity, unsulphonatable residue and flash point of the oil have been specified, but it is realized that in present circumstances it may not be possible always to obtain an oil corresponding exactly to that recommended. The determination of the pyrethrin content should be made by the method of Wilcoxon and Holoday as modified by Dr. J. T. Martin (Rothamsted Experimental Station) and Mr. S. Brightwell (Imperial Institute). As a stabilizer it is recommenced that 2·5 per cent by volume of a 10 per cent solution (w./v.) of pyrocatechol in ether be added to the mixture.

The Committee accepted this specification as a standard insecticidal spray and emphasized the need for a biological test for comparing other sprays with it. At the Committee's suggestion, the development of such a test of the insecticidal power of a spray was undertaken at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research. It was decided to concentrate attention first on the film effect as being the most important for the purpose for which the sprays would be used, although, for a complete comparison, the effect of direct spraying and any fumigant action would also need to be measured by independent methods. With the knowledge which has been gained in devising the film test, however, the establishment of suitable techniques for evaluating the spray and fumigant effects should not be difficult.

The test of the film effect of an insecticidal spray consists essentially of the exposure of a number of insects, bred and handled under standard conditions, on a surface to which has been applied a measured quantity of insecticide. The number of insects dead after a given time is counted and the results are analysed statistically.

The test insects are flour beetles, *Tribolium castaneum* Hb., bred on wholemeal flour protected from infestation by mites and kept under standardized and controlled conditions at 24° C. and 70 per cent relative humidity. The beetles are tested when they are 3–5 weeks old. Careful organization is necessary to ensure a steady supply of insects for test. A spraying tower designed by Dr. Potter[3] is used to apply the insecticide, which is atomized through a nozzle at the top of the tower by air at a pressure of 15 cm. of mercury. The selection of a suitable substrate on which to deposit the insecticide caused some difficulty, but after a number of materials had been tried, Whatman No. 544 filter paper was found to be the most satisfactory. A range of deposits is chosen to cause mortalities of 30–90 per cent after both 6 and 9 days exposure. With the *T. castaneum* stocks in use at present at the Pest Infestation Laboratory a range of deposits of the standard spray (0·8 per cent pyrethrin I) from about 1·55 to 2·62 mgm. per sq. cm. are needed. This range is covered by spraying six or seven papers with increasing deposits, but two to three additional deposits of about 2·0 mgm. per sq. cm. are made to fix with greater certainty the position of the regression line in the region of 50 per cent kill. Fifty beetles are placed on each of the sprayed papers and confined by a glass ring 6 cm. in diameter. The exposure is made in the dark at 24° C. and 70 per cent relative humidity. Controls are also kept, in similar conditions, on untreated paper. The dead insects, that is, those showing no spontaneous movement even when lightly pressed on the metasternum, are counted after 6 and 9 days.

The influence of several factors on the homogeneity of the results has been investigated. In particular, the importance has been shown of allowing beetles time to recover from the mechanical shock inherent in the method of counting into batches. It has been found necessary to pay special attention to the cleanliness of all jars, plates and rings used, freeing them from traces of alkali, which is liable to remain after washing in soapy water, and protecting them, and especially jars containing insects awaiting exposure, from drifting mist of insecticide in the spraying laboratory.

Comparison of insecticides should be made on the results of the nine days count, unless there is reason to suppose that the figures for six days would be more reliable. The data, representing observed mortalities between 30 per cent and 90 per cent for known deposits of insecticide, are analysed statistically by the method described by Bliss[4]. Data obtained from a film test, as described above, should be homogeneous with respect to goodness of fit to the provisional regression line. When two insecticides are being compared, agreement in position and slope of their regression lines may be compared by the direct χ^2 test given by Bliss. If the data are heterogeneous and it is desired to proceed with the comparison, the '*t*' test should be used.

Experiments have shown that this technique will clearly distinguish a standard type of insecticide containing 0·8 per cent pyrethrin I from a similar spray containing 0·65 per cent. In most instances the test will distinguish 0·7 per cent from 0·8 per cent, and 0·7 per cent should ultimately become the reliable limit. Such a limit is considered satisfactory for the purposes to which it is intended to apply this test and it is doubtful whether the method could be made to work within closer limits except, perhaps, after a detailed investigation which is unwarranted in the present circumstances.

It is proposed to apply the test to the comparison of new sprays with the standard as the study of insecticidal materials brings to light substances worthy of trial. It will also be used to select the most suitable of the existing sprays for use in the different conditions which arise in practical pest control in industry.

A full account of the development of this test is being prepared for publication.

[1] *Ann. App. Biol.*, **22**, 769 (1935); **25**, 836 (1938).

[2] NATURE, **145**, 462 (1940); **147**, 388 (1941).

[3] *Ann. Appl. Biol.*, **28**, 142 (1941).

[4] *Ann. Appl. Biol.*, **22** (1), 134; (2) 307 (1935).

SCIENCE AND PRACTICE IN AGRICULTURE

So long as farming was a cycle of routine operations conducted at what we should now call a low-level production, there was little need for any technical knowledge beyond that derived from a thorough farm training in the local husbandry. When the production of crops and stock came under scientific examination rather more than a century ago, the clearer understanding of the principles involved in farming operations began to make technical advances possible. Some of them, such as the introduction of artificial fertilizers, were advances of the first magnitude, and presented completely new possibilities to the farming community. There then developed a need which has lost none of its urgency in spite of all the efforts made to meet it: How are we to bridge the gap between the laboratory and the field, between the man of science who provides the key to improved methods of production, and the farmer whose business it is to put them into successful operation? In the early years this task fell to the few agricultural societies with their old-established journals, the research stations being represented only by Rothamsted, and the colleges only by the Royal Agricultural College at Cirencester. Gradually the organization of agricultural research and education was built up into the form we know to-day. This organization has done excellent work, but agriculture in Great Britain is now faced with the biggest task in its history, and the success achieved will largely depend on the extent to which existing knowledge and new developments can be presented to ordinary farmers in a way that will gain their confidence and prompt acceptance.

This subject, under the title of "The Better Dissemination of Scientific Knowledge among British Farmers", formed the basis of a discussion recently held by the Parliamentary and Scientific Committee. Most of those taking part spoke with the authority derived from a life-long experience of agricultural research and farming affairs, and the proceedings served to bring out clearly the essential points of the problem.

The results of scientific research will only appeal to farmers if they bear clearly and directly on current agricultural questions. This in itself presents a difficulty because research is necessarily slow, and in so far as it involves field trials, its pace cannot be increased. Consequently the scientific workers must have long notice of problems which will sooner or later begin to attract the anxious interest of the farming community. When the country's agricultural policy is vague and in a state of improvisation, as it has been in the period between the War of 1914–18 and the present War, the planning of research is difficult. A well-defined agricultural system brings out the important problems more clearly, and the fact that they are being studied leads to close co-operation between research and advisory workers and the farmers. This tendency is seen, for example, in such places as New Zealand and Denmark, where an important part of the farming is devoted almost exclusively to the production of a standard product for the export market.

In Great Britain a settled agricultural policy would be of the greatest assistance to research workers, advisory staffs and the farming community. There are naturally many forms that such a policy might take, but one of the most attractive was advocated in the discussion by Sir John Russell, when he pointed out that a plan for farming based on the nutritional needs of the country would provide very favourable conditions for agricultural research and the ready application of its results to current problems.

In order fully to exploit new technical advances, there must be a certain elasticity and receptivity of mind on the part of the farming community. All were agreed that the time to develop this is in early life. Improved general education followed by vocational training should help greatly here, together with the Young Farmers' Clubs with their wisely chosen programmes of practical work, judgment, and discussion. Deep technical knowledge is scarcely essential at this stage, though facilities exist in the university departments of agriculture for those who want to specialize; rather should the young farmer know in a general way what type of technical information is available and where to go for it. This is not to underrate the value of a scientific background. In a written communication, Dr. W. K. Slater pointed out that a change in methods may be undertaken more readily if the underlying reasons are understood. A full explanation of a new system, going right down to scientific principles, is sometimes the best method of approach.

The best method of presenting agricultural information and advice is almost always by a personal visit of the advisor to the farmer. In this way the transaction acquires a directness and intimacy that no other means can approach. Objections and questions can be dealt with immediately and all relevant information is normally accessible. But the personnel of this advisory service is regarded as highly important. The research worker himself may not be the best man for the job ; indeed it is seldom that the scientific worker has had the time or opportunity to acquire that thorough first-hand experience of the land which counts so much in farming circles. The type of man chosen for this work should therefore be perfectly sound on the practical side, with sufficient experience of management to be able to regard a proposed course of action from the farmer's point of view. He must also have enough scientific knowledge to understand the work of the research department and explain its more practical aspects to those who would have to apply them.

Next in importance comes the demonstration farm, where technical improvements may be seen in operation alongside the older methods. The effect is often convincing, but the improvement must always be regarded in its agricultural context, and may have to be modified under expert guidance to suit some local set of conditions. This method is being used with considerable effect by the County War Agricultural Committees, who have set themselves the task of putting up straightforward illustrations of improved methods throughout their areas. A demonstration by itself can seldom be entirely satisfactory ; it should have competent demonstrators, and the resulting informal discussions on the headland of the field provide perhaps the most convincing type of farmers' lecture.

Farmers are not great readers ; certainly not of the more scientific journals or even of the popular expositions of agricultural research. The limited number who are in close touch with science and education or are active supporters of the leading agricultural societies are in no way typical of the general body. For wide consumption accounts of new methods must be written in a very direct style shorn of scientific technicalities. Official bulletins, the weekly agricultural Press and, in expert hands, the local Press, can do good work in this direction. Farmers should feel, however, that they have always some specialist within reach who would discuss and amplify information derived from these sources.

In most matters relating to British agriculture the tendency is to make comparisons, sometimes rather unfavourable, with the achievements of the Dominions or foreign countries. Lord Bledisloe, in his opening survey of the position of agricultural research and advisory work in the many countries of which he has had first-hand knowledge, certainly gave the impression that, on the whole, agricultural information is more widely disseminated and more readily received elsewhere than it is in Great Britain. Some of the reasons for this, such as a more fixed agricultural policy and more general technical education, have already been mentioned. In addition, in many countries agriculture has been a much more vital concern than in Great Britain before the War, and, in the Dominions at any rate, the race of farmers have a shorter background of traditional methods, and consequently feel less settled in their ways. Most of the methods of disseminating knowledge used elsewhere appear to have their close counterparts here, although it is possible that in Great Britain they may be handled with less vigour and effect. It was pointed out that our agricultural education, being planned on a county basis, is often uneven in quality, the wealthier and possibly less agricultural counties being in a position to spend more than the others. There is room here for some form of central finance and direction that will make for a more uniform standard. This point was elaborated by Dr. Slater, who suggested that there should be one national service for the dissemination of scientific information under a technically trained director who would control both the advisory and the county staffs, maintaining the scientific standard of the former and the quality of the instruction given by the latter. He would foster collaboration between the two branches, and maintain close contact with the research institutes. Because a system is successful abroad it by no means follows that it is best for British conditions ; nevertheless, the feeling was that the methods employed in northern Europe might well repay study by a travelling mission.

There is no doubt that the activities of the County War Agricultural Committees will have a great influence on the dissemination of technical information to farmers in Great Britain. In many cases their problem is to grade up the weaker farmers towards the level of the better ones : not so much of developing new knowledge but rather of bringing into general acceptance the methods that have been practised on progressive farms for years. In duties of this kind the committees must have obtained a clearer and much more detailed picture of the state of English farms and the technical needs of English farmers than ever before. In the discussion, certain speakers advocated the retention of the agricultural committees in some modified form after the War. However this may be, the large body of workers now engaged on advisory work on behalf of the committees are building up a body of knowledge and experience that should be invaluable when, as we hope, science will have to serve practice in a planned post-war agriculture.

RECENT PROGRESS IN HEAT TRANSFER*

By PROF. C. H. LANDER, C.B.E.

Linking theory with practice is always beset with difficulties, and in no branch of engineering science are these greater than in heat transfer. In a modern boiler, for example, heat is conveyed from the fuel to the water-tubes by direct radiation from the firebed, and from incandescent soot particles, carbon dioxide and water vapour in the furnace gases, as well as by reflected radiation from surrounding refractories, and by convection from the gases. The rational approach to such a complex set of conditions is undoubtedly first to determine the fundamental laws of radiation, convection, etc., and then to apply them in building up a picture of what is happening in the actual furnace. Ways of improvement can then be foretold, and new designs worked out.

The fundamental laws of heat transfer are now fairly well known, but appliances involving heat transfer are still designed largely by trial and error, and any departure from traditional design is still viewed by many with apprehension. While it is no doubt true that the quickest way to design an appliance that will work is usually to follow well-tried principles, it is only by persevering with attempts to rationalize our knowledge that the best use can be made of science, and the engineer given the fullest help in his struggle towards increased efficiency.

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* Substance of the opening paper at a discussion at the Institution of Mechanical Engineers on April 24.

Since radiation and convection are distinct phenomena, obeying different laws, they must be treated independently; and it is convenient also to consider separately heat transfer to evaporating liquids, and from condensing vapours, although they both bear a relation to convection.

Radiation and Emissivity

In heat transfer problems, the engineer is concerned only with the radiant energy emitted by all matter with increasing intensity as its temperature rises, commonly known as 'heat radiation'. The laws of black-body radiation are well known, but numerical calculations entail a knowledge of emissivity, which, since most actual surfaces are selective emitters, changes with temperature. Nothing like a full range of values has yet been determined, and the exact condition of industrial surfaces often cannot be specified.

There is still much to be learned about the selective emission of hot gases and flames. Water vapour and carbon dioxide, being products of combustion of all ordinary fuels, are of particular interest. Schack, in 1924, attempted calculations from infra-red absorption data, but there was so much uncertainty about the limits of the absorption bands, and the variation of the coefficient of absorption within them, that probably the most important outcome of his work was that it led others to make direct measurements. Their results agreed well for carbon dioxide, but were at variance for water vapour. Emissivity was given for different values of the product of the partial pressure and the thickness of the gas layer, and so tacitly assumed that the radiation depends only upon the total number of radiating molecules, and not upon whether they are spread out over a thicker layer with a smaller partial pressure, or compressed into a thinner layer with a higher partial pressure. Eckert and McCaig independently, however, have shown that for water vapour, although not for carbon dioxide, the emission may depend to a considerable degree upon the partial pressure and thickness of the gas layer separately, as well as upon their product.

In industrial plant, with flue gases, or gases containing steam, gas radiation may far outweigh convection. Thus Fishenden, measuring directly the heat transfer from the products of combustion of town's gas, flowing at 2–3 ft. a second through a 1-ft. pipe, found gas radiation varying from three times convection at 1,000° F. to ten times at 2,000° F. Admittedly, the velocities were low, but at higher temperatures, such as are found in many industrial furnaces, the relative importance of gas radiation rapidly increases.

So far, no really systematic experiments have been made on the emission from luminous gases or flames. If the suspended particles causing the luminosity are opaque, the emission, like that for non-luminous radiation, increases according to an exponential law, but for particles small enough to be partially transparent the case is much more complicated. There have been various attempts to evaluate furnace radiation, or to devise instruments for measuring it, but only on arbitrary and empirical lines.

Convection

The recent development of dimensional methods of correlating convection data has widened their range of application, and so greatly accelerated progress. Thus, experiments under pressure with surfaces only a few inches high may be used to deduce the heat transfer from surfaces several feet high at atmospheric pressure; or experiments in gases may be used to deduce the heat transfer in liquids. The most important dimensionless groups used in heat transfer are as follows:

The *Reynolds number* or *Re*, Vl/ν, or (velocity × characteristic linear dimension)/(kinematic viscosity), which determines the distribution of velocity in a stream of fluid flowing past a surface.

The *Prandtl number* or *Pr*, $c\nu/k$, or (specific heat per unit volume at constant pressure × kinematic viscosity)/(thermal conductivity), which determines the distribution of temperature in a fluid, the distribution of velocity already being given by *Re*. For example, in flow through a pipe, the velocity distribution is determined by *Re*, the temperature distribution by both *Re* and *Pr*.

The *Grashof number*, or *Gr*, $ag\theta l^3/\nu^2$, or (coefficient of expansion × gravitational constant × temperature difference × cube of characteristic linear dimension)/(square of kinematic viscosity), which is used only in natural convection, where, together with *Pr*, it determines the distribution of both velocity and temperature.

The *Nusselt number*, or *Nu*, $Hl/k\theta$, or (heat transfer per unit area per unit time × linear dimension)/(thermal conductivity × temperature difference).

Natural convection. Saunders has shown that theory suggests a satisfactory correlation of natural convection data by relating *Nu* with *Gr.Pr*, since, although there is actually a slight residual effect of *Pr*, this is negligible except in the extreme case of mercury, for which *Pr* is exceptionally low. Experiment amply confirms this, and curves are now available over a wide range for vertical and horizontal planes, and vertical and horizontal cylinders.

The transfer of heat across a layer of fluid between a hot and a cold surface is an interesting case of natural convection. By plotting the ratio of actual heat transfer to calculated conduction the results for gases and liquids can be correlated. The results for parallel vertical surfaces, and for concentric horizontal or vertical cylinders, lie on the same curve, provided the ratio of outer to inner cylinder diameter is small, say less than about five.

Forced convection: Flow across banks of tubes. Data on heat transfer and pressure drop in the flow of gases across banks of tubes are vital in designing efficient economizer and superheater units, as well as many types of forced-circulation boilers and heat interchangers. The first systematic investigation was by Reiher in 1925. He measured the total heat transfer and pressure drop for two spacings of tubes, and for both 'in-line' and 'staggered' formations. His work, however, did not cover a wide enough range for deducing general laws, and it was not until Pierson, Huge and Grimison's work in 1937 that satisfactory correlation became feasible. It has now been shown that the heat transfer can be closely related to the velocity in the narrowest restriction between the tubes.

The designer will usually be concerned with obtaining the greatest possible heat transfer for a given pressure drop. For a given mass flow, the lower the velocity, the smaller the pressure drop, and the smaller also the heat transfer for any given surface. Hence a compromise is necessary between the limitations of pressure drop and of space.

Heat Transfer and Fluid Friction

Osborne Reynolds, in 1874, pointed out the analogy between the transfer of heat and the transfer of momentum through an eddying fluid. Recently, with the conception of a more or less stationary film of fluid in contact with the surface, it has been realized that Reynolds' theory must be modified to take account of the two successive stages of heat transfer, first through the stationary film by conduction, and then into the core of the fluid by turbulence.

Boiling Liquids

Three distinct stages are now recognized in the boiling of liquids. The first stage, in which there is no appreciable bubbling, corresponds to the heating-up process before the boiling point has been reached. In the second stage, chains of bubbles rise from the heating surface, their sweeping and stirring effect increasing with the violence of the boiling. As the temperature difference is increased, there comes the third stage, in which the vapour bubbles tend to merge, until they may ultimately form a continuous layer over the heating surface. In the first stage, the heat transfer can be calculated from the appropriate convection data. In the second, or bubbling, stage, the heat transfer is relatively very high, and increases with the temperature difference until the final, or 'film', stage is approached. A sharp decrease then occurs, owing to the blanketing effect of the vapour layer. Hence, there is an optimum temperature difference, which depends upon the nature and condition of the surface, and particularly upon whether or not it is wettable.

Experiments on boiling liquids are of exceptional difficulty for, if the load is high, there may be considerable temperature differences both through, and over the surface of, even metal heating surfaces. Moreover, surface conditions, which greatly influence the rate of heat transfer, may change with time. Thus it is not surprising that no altogether satisfactory correlation of the experimental data has yet been achieved, although many attempts have been made. Surface tension and viscosity, however, are known to be important factors.

Condensing Steam

Nowadays, in designing condensers and evaporators it is essential to know the heat transfer coefficients from condensing steam. The condition of the surface is a very important factor. On a rough surface, free from grease, the condensate spreads out in a continuous film; but on a smooth, greasy surface it tends to form in separate droplets, giving five or ten times the heat transfer of a film. Consequently, much interest is being shown in finding effective 'promoters' of dropwise condensation.

Small proportions of air in steam, by introducing an additional thermal resistance, greatly reduce the heat transfer.

Conclusions

During recent years the engineer has looked more and more to fundamental science for help in his problems of design and working, and, on the other hand, the pure scientist has shown an increasing readiness to admit the importance of industrial applications. Although in full-scale plant, even when scientifically controlled, the conditions can never be specified with the accuracy possible in small-scale laboratory apparatus, key calculations can often give the designer a valuable pointer in deciding what changes are most likely to lead to improved results. There are still many gaps to be bridged, both in basic knowledge and in methods of using it, but much real progress has been made.

OBITUARIES

Prof. W. J. Young

Prof. W. J. Young, whose death occurred recently in Australia, was best known for the work on the breakdown of carbohydrate by yeast which was carried out in conjunction with the late Sir Arthur Harden between the years 1904 and 1913.

The classical researches of Harden and Young on the fermentation of carbohydrate by yeast established the phosphorylation of carbohydrate as an essential stage in the conversion of sugar to alcohol and carbon dioxide, and finally Young successfully accomplished the isolation of a hexose diphosphate. A quantitative relation was demonstrated, the amount of carbon dioxide liberated being proportional to the amount of inorganic phosphate which disappeared from the solution. The process of phosphorylation thus established as essential for the breakdown of carbohydrate by yeast was later shown by Embden and his colleagues to be also a necessary stage in the transformation of carbohydrate to lactic acid carried out by the muscle cell of the animal organism, and by Robison to play an important part in the ossification of cartilage. Harden and Young had laid the foundations of carbohydrate biochemistry, when they showed that it is by the process of phosphorylation that the living organism changes the starch and sugar molecules into the simple substances which are their final products.

After nearly ten years of fruitful co-operation with Harden, Young accepted the post of biochemist to the Institute of Tropical Medicine at Townsville, Australia, and left the Lister Institute. Some years later he was appointed professor of biochemistry in the University of Melbourne. There he became greatly interested in the teaching of biochemistry and built up a very fine department, paying special attention to the needs of medical students. His published papers during this period were concerned chiefly with the natural products of Australia and with problems brought to him for investigation.

Young was a man of wide interests and nothing gave him more pleasure than a friendly argument with his colleagues on every variety of subject. He was keenly interested in politics; and whatever subject he followed he devoted himself to it with enthusiasm, whether it was carbohydrate chemistry or the game of golf.

He will be remembered with affection by his former colleagues at the Lister Institute. He leaves a widow and a daughter, Sylvia, now practising medicine.

I. Smedley-MacLean.

Dr. W. E. Thrift

Dr. William Edward Thrift, provost of Trinity College, Dublin, who died on April 23, was born in 1870, and educated at the High School and at Trinity College, Dublin, where he obtained every distinction in mathematics and experimental physics for which it was possible for him to compete. He crowned his career as a student by obtaining a fellowship in mathematics and experimental science at the early age of twenty-six, and five years later, on the death of FitzGerald, was appointed as his successor in the chair of experimental and natural philosophy. This involved much teaching and administrative work, which was increased by the wideness of his interests, and the many demands for the benefit of his co-operation and advice on the boards of various institutions for the advancement of education and other important and beneficent purposes. In 1902 he was elected to the Science Section of the Council of the Royal Dublin Society, of which he remained a member until his death. He also acted for many years as financial adviser to the Representative Body of the Church of Ireland.

Shortly after his appointment, Prof. Thrift assisted in the editing of the collected works of his great predecessor, George Francis FitzGerald. Then came the task of planning the new physical laboratory which was provided for Trinity College by the munificence of the late Earl of Iveagh, and in 1908 he played a prominent part in making the local arrangements needed for the visit of the British Association to Dublin. A few years later he edited the fourth edition of Preston's "Light", and added a number of sections, bringing that valuable work up to date.

The demands on Prof. Thrift's time, however, became more and more insistent, and his election as one of the representatives of the University of Dublin in Dail Eireann in 1922 (a seat which he retained until the abolition of university representation in 1937) effectively prevented his further participation in work of a purely scientific nature, apart from the lecturing and teaching duties of his chair. Prof. Thrift became a senior fellow of Trinity College in 1928, vice-provost in 1935, and provost in 1937, a position the onerous duties of which he worthily carried out, even when they were rendered doubly difficult by the failing health which marked his closing years.

Prof. Thrift was an excellent lecturer—especially to senior students—and a sympathetic, though critical, examiner. Although debarred by his many activities from undertaking much serious research work himself, he was always most anxious to encourage and assist in that of his students, and his quick grasp of a subject, combined with his keen critical judgment, were of great help to all who sought his aid in their various problems. He was the kindest and most considerate of men to those who had the good fortune to study or work under him, and has given them good cause to feel that they have lost a friend whose name they will long remember with affection and esteem.

H. H. Poole.

We regret to announce the following deaths:

Dr. Herbert Fox, professor of comparative pathology in the University of Philadelphia and director of the Laboratory of Comparative Pathology, Zoological Society of Philadelphia, and author of "Disease in Captive Animals and Birds", aged sixty-one.

Dr. Jacob Reighard, emeritus professor of zoology at the University of Michigan, on February 14, aged eighty.

Dr. C. D. Sherborn, associate of the Linnean Society, compiler of the "Index Animalium", on June 21.

Mr. E. J. Wortley, C.M.G., formerly director of agriculture, Trinidad, on April 27.

NEWS and VIEWS

The Right Hon. Lord Hankey, P.C., G.C.B., G.C.M.G., G.C.V.O.

The election of Lord Hankey as fellow of the Royal Society under Statute 12 recognizes in a most fitting way his unremitting work to secure the recognition of the part which science and scientific men can play in the successful prosecution of the War. When the Scientific Advisory Committee was set up in April 1940, with the status of a Sub-Committee of the War Cabinet, Lord Hankey was appointed its chairman. He brought to it his unrivalled knowledge not only of the machinery of government but also of the diverse ways in which science was already being called upon by the Service and Supply Departments. But to knowledge there was added a warm personal sympathy with the desire of scientific men to give still more. Unfortunately, the time has not yet come to tell the whole story of the work of the Scientific Advisory Committee or of the Engineering Advisory Committee which was appointed later, also under Lord Hankey's chairmanship, to watch over the fuller utilization of engineering knowledge and ability. Sufficient is known, however, to make it clear that these Committees have more than justified their appointment. Lord Hankey vacated the chairmanship of the Scientific Advisory Committee and of the Engineering Advisory Committee when he left the Government earlier this year, but he has retained his charge of the Technical Personnel Committee, which continues vigorously to ensure that a sufficient supply of scientifically trained men is available for the continuing demands of the Services and war industries.

New Foreign Members of the Royal Society

The following have been elected foreign members of the Royal Society: Prof. Alfred N. Richards, professor of pharmacology in the University of Pennsylvania; Prof. L. Ruzicka, professor of organic chemistry in the Federal Technical College, Zurich; Prof. N. I. Vavilov, of Leningrad and Moscow; Prof. I. M. Vinogradov, of Moscow.

Prof. Alfred N. Richards

Prof. Alfred Newton Richards, who is now the vice-president of the University of Pennsylvania, with special responsibility for its important Medical School, has been engaged for a large part of his working life in experimental researches on the method of formation of urine by the kidney, over a wide range of vertebrate types. By original methods of great beauty and refinement, he has provided some of the most important available evidence concerning this excretory function. During the War of 1914–18, he crossed the Atlantic at short notice, in 1917, to collaborate with Dr. (now Sir Henry) Dale and the late Dr. P. P. Laidlaw in researches on traumatic shock, and joined with these workers in publications on the action of histamine and on related problems. Last year Prof. Richards became the first chairman of the newly appointed Committee on Medical Research of the United States, under the Office of Scientific Research and Development. No man is more fitted than he to promote the friendly collaboration in medical researches of the whole English-speaking world, both now and after the War.

Prof. L. Ruzicka

THE arrival, all too infrequently, of neatly blue-bound reprints continues to remind us of the energetic prosecution of the steroid hormone field by the school of chemistry in Zurich. Two and a half years ago we had the pleasure of referring to Prof. L. Ruzicka's election as a Nobel Laureate for the year 1939—an honour which he shared with Prof. Butenandt (NATURE, 144, 858; 1939). A brief account was given there of the work for which the award was made. To-day we welcome Prof. Ruzicka's election to the foreign membership of the Royal Society. His work forms the basis of the advances leading to the whole subject of the steroid hormones. It will be remembered that his great contribution consisted in his recognition of the importance of the residual part of the sterol molecule which remained after removal of the side chain. With characteristic insight Ruzicka realized that which the Göttingen workers had failed to see; namely, that the cyclopentenophenanthrene nucleus left after the above operations presented a jumping-off ground for further important investigations. There followed that brilliant series of researches leading to the male hormone progesterone, corticosterone and so on. It will be recalled that his early publications resulted in one of the most bitter polemics in science the century has known. Since the Nobel award, Ruzicka's main work has been the extension and amplification of the various substances that can be made from sterol disintegration. Numerous papers have appeared from his laboratory, many of which have recently arrived in Great Britain.

Prof. N. I. Vavilov

PROF. NICHOLAS IVANOVITCH VAVILOV's most important work has been on the origin of cultivated plants. His method was to make well-planned expeditions to those regions where cultivated plants grow wild, and he obtained strong evidence that countries where a large number of varieties of a particular plant occurs are the actual areas of origin. Conditions favouring genetical instability would, he argued, probably lead to the formation of a new species. It is remarkable how narrow is the belt along which cultivated plants arose. Mexico and Central America are the source for the New World, and Abyssinia, Persia, Afghanistan and an extension of this zone across Northern India into China, furnished the Old World with its crops. Prof. Vavilov has discussed the close relations between the origins of cultivated plants, of animals, and of ancient civilizations. He is, however, no mere collector. His material was taken back to Russia and there grown and studied in detail. He has become the leading taxonomist of cultivated plants, and he has also done valuable plant-breeding work and made important contributions to genetical science. He is well known to British and American scientific workers, having studied at the John Innes Horticultural Institution and visited various research centres, such as Rothamsted and others in Great Britain and also in the United States; and his complete command of the English language and lively humour and social gifts have always made him a welcome guest. His election to this new distinction will cause much satisfaction to many in Great Britain.

Prof. I. M. Vinogradov

PROF. I. M. VINOGRADOV is a member of the Academy of Sciences of the U.S.S.R. and he is universally acknowledged as the world's foremost investigator in the analytic theory of numbers. For years past he has produced a succession of discoveries, some of which can be described in no other way than as epoch-making. Many others are of vital importance and have also made mathematical history. They are already part of the fundamental equipment which must be acquired by anyone who studies number-theory. Many problems, in which there seemed little or no hope of any progress, yielded to his methods, which combine a wonderful imagination, great power and comparative simplicity; their possibilities have not begun to be exhausted. His most famous work is associated with Goldbach's theorem that every even number is the sum of two prime numbers. This theorem has been known for about two hundred years, but has never been proved. Vinogradov proved that every sufficiently large odd number is the sum of three primes. This is a result of a type, so difficult to prove, that it was considered a notable achievement when progress was made about twenty years ago by Hardy and Littlewood; even though their proof depended upon making assumptions of a type as difficult to prove as the famous Riemann hypothesis. The importance of Vinogradov's results may be gauged from the pecuniary recognition given to him by the Soviet Government. Well known also is his new solution of Waring's problem, leading to results far more precise than those first discovered by Hardy and Littlewood.

Two Eminent German Men of Science

IN the first week of July occur the bicentenary of the birth of the German physicist and writer, Georg Christoph Lichtenberg, of Göttingen, and the centenary of the birth of the German chemist, Albert Ladenburg, both of whom were well known in British scientific circles. Lichtenberg was born on July 1, 1742, at Oberramstadt near Darmstadt, and was the youngest child in a family of eighteen. As a youth he became a hunchback and was thus confined more or less to sedentary occupations. Entering the University of Göttingen at the age of twenty-one, he afterwards worked at the Observatory and when twenty-eight was made professor of mathematics. His first visit to England was made in 1770; his second in 1774. He was then made a fellow of the Royal Society. Returning to Göttingen in 1775, he became tutor to the Dukes of Clarence, Cumberland and Cambridge, and two years later was chosen to succeed Erxleben in the chair of physics, a post he held until his death on February 24, 1799. As a physicist he is remembered for his observations on the figures produced by fine dust on the surfaces of electrified plane surfaces. His electrical experiments led to a correspondence with Volta. Lichtenberg was also well known as a friend of Garrick and a writer on Hogarth.

Albert Ladenberg was born on July 2, 1842, at Mannheim, his parents being Jews. From Karlsruhe Polytechnic he went to Heidelberg to work under Bunsen and Kirchhoff, and he afterwards worked with Kekulé at Ghent and with Wurtz and Friedel in Paris. In 1872 he was appointed professor of chemistry at Kiel, and it was there that he began his important researches on vegetable alkaloids. In 1889 he became professor of chemistry in the University of Breslau and he held this position until 1909. He died on August 15, 1911. While yet a *privatdocent*, Ladenburg began to lecture on the history of chemistry, and during the space of forty years various editions of his "History of the Development of Chemistry during the past 100 Years" appeared in German, French and English. In Great Britain he was awarded the Davy Medal of the Royal Society and the Hanbury Medal, and was made an honorary member of the Chemical Society. A memorial lecture on his life and work was delivered to the Chemical Society by Dr. Kipping on October 23, 1913.

Mineral Resources and the Atlantic Charter

THE Conference on "Mineral Resources and the Atlantic Charter", arranged by the Division for the Social and International Relations of Science of the British Association, is to be held in the theatre of the London School of Hygiene and Tropical Medicine, Keppel Street, Bloomsbury, London, on July 24 and 25. There will be morning and afternoon sessions on each day, beginning at 10 a.m. and 2.15 p.m. The subjects of the successive sessions are intended, broadly speaking, to be classified respectively as: (1) distributional, in the geological and geographical aspects; (2) the preceding considerations as applicable to certain mineral products; (3) new sources and materials; (4) economic and planning considerations. The Conference will be opened by Sir Richard Gregory, president of the Association, and the chair at the successive sessions will be taken by Sir Thomas Holland, Sir William Larke, Dr. C. H. Desch and the Right Hon. Sir Stafford Cripps. Among expected speakers are Prof. H. H. Read, Prof. C. B. Fawcett, Prof. W. R. Jones, Sir Lewis Fermor, Dr. E. F. Armstrong, Dr. W. H. Hatfield, Dr. L. Dudley Stamp and Prof. J. G. Smith. Admission to the Conference will be by ticket, obtainable from the British Association, Burlington House, London, W.1; tickets will be issued, so far as accommodation in the theatre permits, on or after July 13.

Psychology of Hate

DR. ERICH FROMM, in a recent report to the *Journal of the American Home Economics Association*, discussed the two kinds of hatred which he claims exist. One is what he calls the "counterpoint of life". It is rational hatred, aroused by an attack on life, freedom, country, some person or institution we love. Such hatred is necessary for winning a war against aggression. "People must love what they are defending, in order to hate their attackers effectively." The other kind of hatred, which he calls "character-conditioned", was made use of by the Nazis in recruiting their party. The bulk of their recruits came from the lower middle class, who had led a starved and frustrated life socially and economically, particularly since 1918, in Germany. This led to tremendous irrational hatred and destructiveness which could only be expressed in small doses before the Nazi party offered an outlet.

"Destructiveness", says Dr. Fromm, "is the result of unlived life." He believes that this kind of irrational or character-conditioned hatred, which is all too common in our culture, results from the blocking of spontaneity and self-expression in childhood. Parents and teachers have many ways of discouraging self-development in children, from open intimidation to the subtle, 'sweet' type of authority which does not forbid, but says "I know you won't want to do that". Such children grow up with so little confidence in their own wishes and emotions that they can neither love nor hate constructively. Always dependent on other people even for their opinions, they are ready to follow a leader blindly. Their apparent submissiveness hides a dangerous amount of sadistic aggression, ready to be unleashed at the command of a *Führer*. But Dr. Fromm believes that this irrational hatred, utilized by the Germans, Italians and Japanese, is much less effective for winning wars than the positive kind of savagery shown by the Chinese and the Russians in defending their homes. The latter kind of hatred arises only when people are fighting for something they love. While Nazism pretends to fight for the life and existence of the German people, it is basically a movement of nihilism profoundly attracted by destruction. Its motto was adequately expressed by a speech once made by a Fascist officer who ended: "Long live death".

Broadcasts on American Thought and Culture

A NEW series of short-wave broadcasts under the auspices of the American Philosophical Society was inaugurated on April 24 over the non-commercial short-wave radio station WRUL. The world-wide significance of American thought and achievement in the present crisis in our civilization will form the general background of the series; distinguished American authorities will deliver a series of addresses, each in his special field—scientific, sociological and cultural. The American Philosophical Society and the World Wide Broadcasting Foundation have arranged to send out this series of short-wave broadcasts over WRUL from the Society's Hall in historic Independence Square, Philadelphia. They will be directed primarily to countries overseas where the English language is spoken and understood, and where there is still interest in the progress of science and learning and faith in a democratic form of government. WRUL is planning to translate a number of these outstanding talks into other languages for many of the countries covered by its beams; the station now broadcasts in twenty-two languages.

The John Innes Horticultural Institution

THE report of the thirty-second year of the John Innes Horticultural Institute covers the activities during 1942. A considerable number of changes of staff, including the resignations of such well-known individuals as C. Pellew, D. de Winton and B. Schafer, have taken place. Many of the staff have left to take up Government work. In addition, a serious drop in income as a result of war damage to property owned by the Trust has necessitated some reorganization. Nevertheless, an imposing series of research papers (more than fifty) on a large range of subjects, together with several important discoveries, indicate that the Institution is as vigorous as ever.

Among the new results may be mentioned the discovery of a method for testing incompatibility of pollen *in vitro*, the production of polyploid apples and pears by heat treatment, the successful hybridization of *Phaseolus vulgaris* and *P. multiflorus*, and the discovery of the plant with probably the highest chromosome number among wild Angiosperms—*Morus nigra* ($2n = 308$). Highly important work is developing from the theory of polygenes and from the discovery that inert parts of the chromosome may be identified by starvation of nucleic acid. The publication of the John Innes leaflets on horticultural subjects has met with a popular demand, and there has been a large increase in advisory work on horticulture. This is a new and welcome branch of the activities of the John Innes.

A New X-Ray Synthesis

S. H. Yü has recently developed a synthesis of X-ray intensity data which, it is claimed, has certain advantages over the Patterson synthesis. An account of the method has been published in NATURE (June 6, 1942, p.638). S. H. Yü and C. P. Ho have illustrated the synthesis by a detailed treatment of iron pyrites (*Science Records, Academica Sinica*, 1; 1942). In a further study, submitted to NATURE, they have investigated the effect of the approximations necessary in practice, and the conditions for obtaining satisfactory results from the new method. It is necessary to use a mean value for the variation of atomic structure factor with angle; that given by the Thomas-Fermi atom proves to be a sufficient approximation. For a good determination of the atomic parameters the edge of the unit cell must be divided into at least 100 parts. For the synthesis described in NATURE it is necessary to know at least 13 orders of $h00$ to get a good result, but it is shown that it is possible to modify the method so that it is applicable to a smaller number. Yü and Ho are to be congratulated on maintaining scientific research in China in difficult circumstances, and the application of the method to unknown structures will be awaited with interest.

Shortage of Drugs in France

ACCORDING to the *Journal of the American Medical Association* of March 25, the Academy of Medicine of Paris has for months been studying the problem of the shortage of indispensable drugs. At the suggestion of Dr. Georges Duhamel, a committee has been formed to publish periodically a list of drugs and chemical products becoming rare. The majority of raw materials come from foreign countries, and importation of these has mostly been cut off. A second reason consists in the difficulty of transport and the dearth of packing material. In the latest list presented to the Academy the following were said to be extremely scarce or entirely absent: caffeine, theobromine, iodine, camphor, boric acid and its derivatives, quinine, opium and its alkaloids, glycerine, cod liver oil, starch, dextrose, mustard meal, lactose, tartaric and citric acids, insulin, and many other chemical and vegetable products.

Lady Tata Memorial Trust

THE Trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee, they have agreed, if circumstances permit, to make the following awards for research in blood diseases, with special reference to leukæmia, in the academic year beginning on October 1, 1942. Grants for research expenses: Prof. J. Furth (New York); Dr. P. A. Gorer (London); Dr. A. H. T. Robb-Smith (Oxford); Prof. L. Doljanski (Jerusalem). Part-time personal grant for assistance: Dr. W. Jacobson (Cambridge).

The Night Sky in July

THE moon is new on July 13d. 12h. 03m. U.T. and full on July 27d. 19h. 14m. There are no occultations of any bright stars during the month. The following conjunctions occur: July 3d. 23h., Venus in conjunction with Saturn, Venus 0·1° N.; July 9d. 21h., Saturn in conjunction with the moon, Saturn 3° N.; July 10d. 11h., Venus in conjunction with the moon, Venus 4° N.; July 11d. 15h., Mercury in conjunction with the moon, Mercury 3° N.; July 12d. 10h., Jupiter in conjunction with the moon, Jupiter 4° N.; July 16d. 00h., Mars in conjunction with the moon, Mars 3° N.; July 18d. 08h., Mercury in conjunction with Jupiter, Mercury 0·4° S.; July 30, 10h., Mars in conjunction with Regulus, Mars 0·7° N. Mercury is a morning star and is in greatest elongation on July 6 when it is 21° W. Venus is a morning star and souths at 9h. 50m. in the middle of the month. Mars is too close to the sun to be well observed. Jupiter is a morning star, in Gemini, and rises about 2h. 40m. in the middle of the month. Saturn is a morning star and souths about three hours before the sun in the middle of the month. Comet Grigg-Skjellerup can be observed with a small telescope; an ephemeris appeared in NATURE of June 6, p. 636. The earth is at aphelion on July 6.

Announcements

MR. A. GOUGE has been elected president of the Royal Aeronautical Society for the year 1942–43, and Mr. E. F. Relf, superintendent of the Aerodynamics Department, National Physical Laboratory, and Dr. H. Roxbee-Cox, deputy director of scientific research at the Ministry of Aircraft Production, have been elected vice-presidents.

AT the seventy-ninth annual general meeting of the Institution of Gas Engineers, held on June 10, Mr. E. V. Evans, general manager of the South Metropolitan Gas Company, was elected president for the year 1942–43. Mr. Evans, who is also chairman of the Council of the Gas Research Board, is the first chemist to occupy the presidency of the Institution of Gas Engineers.

THE Association of Scientific Workers (with the collaboration of the Federation of Ayrshire Scientific Film Societies) has arranged a Conference on "The Scientific Film and Scientific Film Societies", to be held in two sections: in Ayr on August 1 and 2, and in London on August 16. The Conference will discuss the possibilities of scientific film societies run by branches of the Association of Scientific Workers to give science films the widest possible showing, and will direct public attention to these activities and to the need for increased and co-ordinated production of science films.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Type of Microphotometer

THE following note contains a short description of the principle of a new type of microphotometer, the details of which will be published elsewhere. The main feature of this new device is that it gives a practically instantaneous record of the blackening curve, that is, the distribution of transparency of a photographic plate or a similar object along a straight line, which appears on a fluorescent screen and therefore permits a quick visual survey of the blackening distribution in a whole plate. The new instrument is comparatively small, easily transportable from one place to another, and it contains no delicate or expensive mechanical parts. It can, if necessary, be put together in any laboratory workshop from parts of existing apparatus.

The instrument consists of two separate parts, the 'receiver' and the 'recorder', which are only electrically connected. The receiver consists of a light source (small incandescent lamp), a slit on which the light from the source is concentrated, a microscope objective which forms a reduced image of the slit on the plate under investigation, and a photo-electric cell (cæsium, gas-filled) on the cathode of which the light is finally concentrated. The plate is fixed to one prong of an electromagnetic tuning fork operated by 50 c./sec. A.C. so that it performs a simple harmonic oscillation in its own plane and normal to the direction of the beam.

The recorder consists mainly of a cathode ray oscillograph of commercial type with a two-stage linear amplifier for the deflecting potential in the vertical direction. The input voltage of this amplifier is taken across a high resistance in the anode circuit of the photocell. The deflexion of the cathode ray is therefore proportional to the transparency of the plate at the particular point just passing the slit image. The potential for the deflexion in the horizontal direction is supplied by the same A.C. which operates the tuning fork in such a way that the two oscillations, the mechanical one of the plate and the electrical one of the deflecting field, are exactly in phase. The horizontal deflexion of the cathode ray is therefore exactly proportional to the displacement of the plate. Thus the recorder plots automatically the blackening curve along a line on the plate equal in length to twice the amplitude of its vibration.

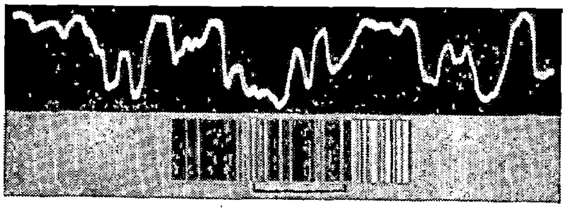

Fig. 1.

UPPER: BLACKENING CURVE OF A PART OF THE PHOTOGRAPH OF A BAND SPECTRUM.

LOWER: ENLARGED POSITIVE OF THE SAME BAND SPECTRUM, THE RECORDED REGION BEING MARKED BELOW.

The magnification of the instrument, that is, the ratio of the horizontal distance of two corresponding points on the screen and on the plate, can be easily and quickly changed by changing the amplitude of the vibration of the fork between about 25 and 500. It is obviously also easy to change the scale of the recording curve in the vertical direction. Hence the instrument can be adjusted to any particular object within a few minutes.

The whole vibrating mechanism can be shifted in the direction of the vibration by means of a micrometer screw. By this procedure the picture on the screen is bodily shifted in a horizontal direction so that different parts of the blackening curve come successively into the field of observation. In this way the blackening curve can be obtained over the whole length of the plate and, if necessary, along a whole set of parallel lines.

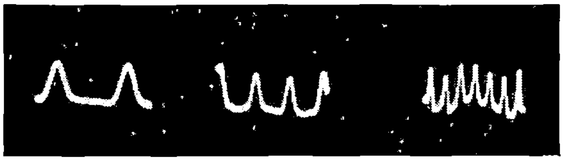

Fig. 2.

RECORDS OF THE BLACKENING CURVE ALONG A MICROSCOPIC SCALE, CONSISTING OF PARALLEL LINES 0·1 MM. APART, TAKEN WITH DIFFERENT MAGNIFICATIONS.

The different parts of the curve can, if so desired, be traced or photographed and afterwards put together for recording purposes. Fig. 1 is an example of such a record. The upper part represents the blackening curve along a certain part of a band spectrum shown in the lower part of the figure. The original magnification factor in this case is approximately 60. Fig. 2 shows the blackening curve along a microscopic scale consisting of parallel lines 0·1 mm. apart, taken with different amplitudes of fork vibration. The magnification factors were 380, 180 and 80 respectively. Although these curves perhaps show less detail than those obtained with the usual kind of microphotometer (mostly because of their thickness) this disadvantage will for many purposes be more than balanced by the advantages mentioned in this note.

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Valency and Orientation

MANY rules have been given[1] with the object of summarizing in an approximate manner the directive effect of substituents on further substitution in benzene. The values of these rules are practical, theoretical and didactic. The instructive value of many of them is often slight because of their complexity, and it is primarily in an attempt to overcome this complexity that I wish to suggest yet another. It is based upon a simple valency rule I have proposed for use in the teaching of elementary chemistry[2]. Like this valency rule, the new orientation rule is in accord with the simple electronic theory of valency; in particular, it is an alternative expression of the simplicities of the somewhat complicated electronic orientation theories of C. K. Ingold[3] and R. Robinson[4]. It can be stated as follows:

If X be the atom attached to the benzene nucleus in a compound C_6H_5Y, then the group Y which contains X is an *ortho/para*-directing group when the valency of X is equal to or less than 4, and a *meta*-

directing group when the valency of *X* is greater than or equal to 4. The accompanying table contains examples illustrating the rule.

Directivity	Valency of atom (*X*) attached to benzene ring (2)	Examples of groups[1] (*Y*)
Predominantly *ortho/para*	0	$-\bar{\mathrm{O}}$ (phenoxide ion)
	1	$-\mathrm{Cl}$, $-\mathrm{Br}$, $-\mathrm{I}$.
	2	$-\mathrm{OH}$, $-\mathrm{O\ Me}$
	3	$-\mathrm{NH_2}$, $\mathrm{NMe_2}$, $-\mathrm{NHAc}$
	4	$-\mathrm{CH_3}$, $-\mathrm{CH_2COOH}$, $-\mathrm{CH_2CN}$
Predominantly *meta*	4	$-\mathrm{CHO}$, $-\mathrm{CN}$, $-\mathrm{COOH}$
	5	$-\mathrm{NO_2}$, $-\overset{+}{\mathrm{A}}\mathrm{sMe_3}$, $-\overset{+}{\mathrm{S}}\mathrm{bMe_3}$
	6	$-\mathrm{SO_2OH}$

There is gradual transition from *ortho/para* to *meta* directivity at X^{IV} but there is practically no ambiguity at any other valency for *X*. The iodonium group containing X^{III} is an exception, and such an exception, together with the duality of directive property which exists at X^{IV}, are to be attributed, as in many existing orientation rules, to the effect either of a formal positive charge on *X*, or of the tendency for such a positive charge to be on *X* due to the influence of adjacent atoms in *Y*. Accordingly, most of the X^{IV}-containing groups which are *meta*-directing either carry a formal positive charge on *X* (for example, sulphonium group), or carry an accumulation of 'negative' atoms or groups (for example, $-\mathrm{CCl_3}$, $-\mathrm{C(COOEt)_3}$), or are unsaturated and liable to polarization (for example, $-\underset{|}{\mathrm{C}}{=}\mathrm{O} \rightarrow -\overset{+}{\underset{|}{\mathrm{C}}}-\overset{-}{\mathrm{O}}$). This tendency to polarization is not so great when *X* is attached to another *X* by a double or triple bond (for example, $-\mathrm{C_6H_5}$, $-\mathrm{CH{:}CH.COO}R$, and $-\mathrm{C{\vdots}C.COO}R$ are predominantly *ortho/para*-directing). Even with these modifications, none of which are new, the transition from *ortho/para* to *meta* directivity at X^{IV} remains the striking feature of the new rule.

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May 28.

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[1] Fieser, L. F., "Organic Chemistry : An Advanced Treatise", edited H. Gilman, 1, 142 (1938).

[2] Copley, G. N., *Chemistry and Industry*, 61, 196 (1942).

[3] *Rec. trav. chim.*, 48, 797 (1929).

[4] *J. Soc. Dyers and Colourists*, 65 (1934).

Calcium Nutrition of the Fœtus

Andersch and Oberst[1] have reported the total and ultrafiltrable calcium and the total protein of sera of twenty-five parturient women and their new-born. The median values for mothers and offspring, respectively, were: total Ca 10·3, 11·7 mgm. per 100 ml.; ultrafiltrable Ca 5·4, 5·3 mgm. per 100 ml.; total proteins 6·46, 5·43 per cent.

The McLean-Hastings mass law equation

$$\frac{[\mathrm{Ca}^{++}]\,[\mathrm{Protein}^{=}]}{[\mathrm{Ca\ Proteinate}]} = K_{\mathrm{Ca\ Proteinate}},$$

can be used with data of the above type[2] and, although the partition of serum calcium between ultrafiltrable and colloidal forms is not an equilibrium governed solely by calcium and protein concentrations[2,3], the equation yields consistent results when applied to means of large groups of data.

The above data yield *p*K values of 2·11 for mothers and 2·37 for offspring. Since the maternal and fœtal ultrafiltrable calcium levels are in equilibrium, this increased calcium-binding power of fœtal plasma colloids allows greater quantities of calcium to be transferred to the fœtal circulation, held in solution and transported, than would be the case if maternal and fœtal colloids were identical. If the Andersch-Oberst data are recalculated with the assumption that there is no difference between the maternal and fœtal colloids, then it is found that the total serum calcium level would have been 9·5 mgm. Thus the increased carrying capacity is 2·2 mgm. Ca per 100 ml. plasma; or, making the same assumption, the data can be recalculated to show that in order to maintain the total serum calcium level at 11·7 mgm., with an ultrafiltrable calcium level of 5·3 mgm., the fœtal proteins would have to be increased to 8·24 per cent.

The necessity of such a mechanism is clear since the fœtus is in competition with the mother and, in spite of having a much smaller blood volume for transport purposes, must deposit in the skeleton almost as much calcium as the mother stores to meet future lactation requirements.

This special type (or distribution) of plasma colloids confers an advantage on the fœtus in calcium transport similar to that of the special fœtal type of hæmoglobin in oxygen transport.

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[1] Andersch, M., and Oberst, F. W., *J. Clin. Investig.*, 15, 131 (1936).

[2] Duckworth, J., and Godden, W., *Biochem. J.*, 30, 1560 (1936).

[3] Ray, S. C., *Biochem. J.*, 33, 1599 (1939).

The Polygene Concept

Drs. Gordon and Sang[1] have, very properly directed attention to the value of studies on the interrelations of environment and genic expression Some of the most fascinating problems of genetics are to be found in this field; indeed, we need go no further than the investigations which these two authors have made on the manifestation of the gen 'Antennaless' in *Drosophila melanogaster*[2] to see how much can be accomplished by such researches.

Now, as Gordon and Sang point out, this question also constitutes one of the major problems in the study of polygenic inheritance; but, in so far as ou aim is to investigate the heritable portion of polygenic variation, the problem raised by non-heritabl influences is a technical one. Non-heritable effect constitute a source of what Fisher has called "error" variation and, as such, affect the precision, though not, in an adequately planned experiment, the rigou of the results[3]. Investigations of the kind made and advocated by Gordon and Sang can be valuable in showing us how to control this error and increas precision; but, whether such control is exercised o not, experiments which are planned, conducted and analysed so as to yield a valid estimate of error wi permit sound conclusions to be drawn. It is equally true that no matter how good control over th sources of error may be, the full value of the observations cannot be extracted unless this error is estimated in the way which is possible only with sound experimental design. The statistical techniques necessar for the conduct of such experiments are more familiar to agronomists than to geneticists, who have had little occasion to use them in the past. Polygenic investigations will, however, require that genetical experimenters become as familiar as agronomists with the principles of experimental design; more especially because these same principles must be used to develop methods as appropriate to the solution of genetical problems as the randomized block, latin square, etc., are to field trials. It would be rash, perhaps, to suppose that all the difficulties of polygenic investigation can be overcome by these means, but suitable experimental design is clearly the primary requirement.

I venture to think that my own experiments[4,5] have been adequate from this point of view, and that, therefore, a certain degree of confidence may be placed in my results. (It should be stated that, for reasons of space, only the outlines of my analyses could be published in some instances.) In any event my experimental technique was sufficient to render it improbable that the results could, as Gordon and Sang suggest, be attributed to the sterility of females in the selection lines, for the following reason. I selected both for increased and decreased number of abdominal chætæ, and obtained a marked response in each direction. Sterility also set in in both lines, with a consequent reduction in the larval population of each culture. It is difficult to see how this reduction could explain the selection results, for in one line it must then be supposed to have resulted in an increase in chæta number, while in the other it resulted in a decrease. Furthermore, a repetition of this selection experiment gave comparable results, even though larval crowding was artificially increased by doubling the number of parent flies per culture.

It may be remarked that, in my experience, reduced fertility appears to be an almost inevitable accompaniment of selective response in any polygenic character of *Drosophila melanogaster*. The reason is probably a mechanical one. Fertility itself must be polygenic and hence its controlling genes will be intermingled, along the chromosomes, with those other polygenes which control the character upon which selection is being practised. Now selective response, on my view, depends mainly on the action of recombination in breaking up polygenic combinations and so releasing heritable variability. Such recombination will affect the polygenic combinations controlling fertility equally with those controlling the character upon which selection is being directly exercised. Correlated response may then be expected to occur, and fertility will be reduced as the chæta number changes. Correlated response to selection would appear to be an inevitable property of polygenic inheritance, and it is of great help to us in understanding some features of evolutionary change, notably the degeneration of unused organs.

Furthermore, correlated response renders it nearly, if not quite, impossible to maintain the fertility of selected females, as Gordon and Sang propose. It also serves to emphasize the absolute necessity of adequate experimental design. K. MATHER.

John Innes Horticultural Institution,
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June 2.

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[1] Gordon, C., and Sang, J. H., NATURE, 149, 610 (1942).
[2] Gordon, C., and Sang, J. H., *Proc. Roy. Soc.*, B, 130, 151 (1941).
[3] Fisher, R. A., "The Design of Experiments" (Edinburgh, 1937).
[4] Mather, K., *J. Genet.*, 41, 159 (1941).
[5] Mather, K., *J. Genet.*, 43, 309 (1942).

Gordon and Sang[1], in commenting upon the important work of Mather[2] on polygenic inheritance, remark that the study of this will only become effective when certain experimental conditions are understood and allowed for. Might I add that there may be a further condition to be fulfilled for its satisfactory development?

It seems to me that it will be necessary first to face and to solve a real methodological difficulty inherent in any work involving the concept of polygenes. Many cases are familiar where several genes, independently known, interact to give certain effects. The evidence for the existence of these genes depends upon ordinary considerations such as the increase in variation seen in the F_2, and in the possibility of establishing so-called 'pure lines' of differing qualities out of the original stock.

In order to account for the behaviour in heredity of a variable quality the behaviour of which cannot be accounted for on the assumption that it depends upon the distribution of the members of a single gene-pair, it seems now to be assumed that its behaviour depends upon the distribution of the members of several such pairs, of which there may be no independent knowledge. If the number of such pairs invoked as relevant be increased just until they are sufficient to explain the observations, a weakness seems to appear in the procedure. The explanation offered becomes, it seems to me, simply epicyclic; that is, closely similar to the explanation of planetary motion by the postulate of any requisite number of epicycles. It will, as epicyclic explanations always will, explain anything: any ratio of types, any degree of the expression of a quality. But what is the scientific value of such an explanation?

Surely it will be necessary to base the estimate of the number of genes to be invoked as relevant on something other than an estimate of how wrong the assumption of a single gene-pair would make the results. Where is this other independent criterion to be sought, if the genes concerned have nearly negligible individual effects or even cannot be isolated?

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June 3.

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[1] Gordon, C., and Sang, J. H., NATURE, 149, 160 (1942).
[2] Mather, K., *J. Genet.*, 41, 159 (1941).

Reflexion from Paper

THE optical effect described by Mr. Burke in NATURE of May 30, p. 613, is well known to the practical papermaker. In matching the tone of a 'white' paper it is essential to employ direct illumination and direct vision. Any angular deviation in lighting or vision gives rise to misleading tones of red or blue.

Dr. V. G. W. Harrison's ingenious explanation does not appear satisfactory for the following reasons: (1) The effect described is characteristic of plain uncoated papers, not 'art papers', which present a non-fibrous surface; (2) the angle at which the maximum effect is observed does not correspond with that of specular reflexion; (3) it explains a possible red colour but not a definite blue tone.

I suggest that the true explanation of this effect may be found in spectral diffraction of part of the reflected light. The orientation of the fibres in the cellulose and of the fibres in the paper produce a kind of grating from which the reflected light is partially diffracted into a spectrum, the red and blue ends of which at a particular distance cover the vision of the right and left eyes respectively.

A similar and more pronounced effect may be observed with certain specimens of polished chalcedony and opal in which it is certainly a diffraction effect, due to a finely striated structure of these minerals.

J. STRACHAN.

New Northfleet Paper Mills, Ltd.,
Kent.

MR. BURKE's observation regarding the reflexion from paper as viewed by the two eyes separately may have an explanation other than that suggested by Dr. Harrison (NATURE, May 30, p. 613). A simple comparator I have in use has magnesium carbonate block reflectors set substantially vertically and parallel to the plane of a large, tall window, so that these very excellent diffusing reflectors receive skylight at roughly 45° incidence. The light reflected normally is received on two first-surface mirrors arranged in a casing and viewed through a tube at one side, so that a square field divided by a barely perceptible vertical septum is observed. Customarily this instrument is set up so that the observer has the window at his left-hand side. Thus the left eye is somewhat exposed to direct light from the window, whereas the right eye is appreciably protected by shadow thrown by the nose. On changing from left to right eye a distinct difference is noticed in the blueness or redness of any near-white field examined, and this is greatly reduced by placing a screen so as to prevent much light from the window striking the left eye.

J. LEONARD BOWEN.

9 The Wiend,
Lower Bebington,
Wirral.

IN NATURE of May 30, Mr. E. Burke points out that "If an open book is illuminated fairly strongly from one side, for example, from over one shoulder, the general colour of the white paper is different for the two eyes when one or the other is closed". Dr. V. G. W. Harrison, commenting on this letter, regards this phenomenon as "due to selective specular reflexion from the paper".

I suggest, however, that this explanation is not the correct one. If one sits reading a book with the light coming over the left shoulder, the left eye is exposed to a certain amount of direct illumination by the light source, while the right eye is shielded from direct illumination by the nose and the nasal edge of its orbit, and is thus only illuminated by light reflected from the interior of the room. This is evident from the fact that while actually reading the book, one sees the illuminant by peripheral vision with the left eye, but not with the right. Under these conditions, the right eye is more dark-adapted than the left eye. Now from the Purkinje phenomenon we know that the subjective brightness of specific colours varies according to the degree of dark-adaptation of the eyes, and it is surely in this direction that the explanation of the phenomenon noticed by Mr. E. Burke is to be sought. Under the conditions described, the right eye would be employing 'rod vision' to a greater extent than the left eye, and differences of colour perception are to be expected.

It is, of course, true that the image of one and the same printed page occupies the foveal area of both retinas, but the phenomena of simultaneous colour contrast show us that central vision is not independent of the nature of the peripheral 'outfield'.

Dr. Harrison's explanation seems to be negatived by the fact that if book and reader are suddenly rotated through 180° without moving the illuminant, the phenomenon described persists unaltered for some time, until a new adaptation takes place.

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June 10.

Origins of Human Graphic Art

As a result of the publication of my note in NATURE of June 6, p. 637, Mr. J. Leonard Bowen, of Port Sunlight, Cheshire, sent me the enclosed letter which seemed to me of such interest that I have obtained his permission to publish it in NATURE. Mr. Bowen tells me that the monkeys were almost certainly the common rhesus monkey, *Macaca mulatta*.

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YOUR note on the "Origins of Human Graphic Art" reminds me of observations I made some years ago at Matheran, near Bombay. Large numbers of large long-tailed monkeys romp about this little hill station and afford much amusement to visitors. I frequently saw such monkeys trace the outline of one of their hands in the dust, using a twig held almost as one would hold a pencil. Other monkeys inspected the traced outlines with a show of interest, walking round and round the spot with what seemed to be an anxious manner.

J. LEONARD BOWEN.

Simplification of Musical Notation

(1) LIKE everything else which has grown up as a result of an evolutionary process, the present musical notation[1] has imperfections; yet it remains superior to our ordinary orthography. It is universally accepted, and there is nothing in it corresponding to the English 'ough' sounds, or to, for example, the differences in the French and Italian pronunciations of 'un' and 'le'.

(2) Apart from the coalescence of sharps and flats on keyboard instruments, the present notation fulfils Lord Brabazon's requirements without ambiguity or redundance.

(3) The present notation is not intended only for keyboard instruments. In music for string quartet

or unaccompanied choir, the distinction between sharps and flats can be made, and is made by good performers. The distinction is not simply of mathematical interest; it is easily perceptible to a moderately good ear. While equal temperament is a necessary evil in keyboard instruments and has no doubt come to stay, there is no point in enforcing it where it is unnecessary.

(4) The key signatures are introduced for convenience, not to make the music look difficult. For example, in the key of D major the notes F♯ and C♯ are constantly recurring, while F♮ and C♮ occur only exceptionally. The regularity is therefore noted once and for all at the beginning of the piece, and only the exceptions are noted afterwards. If key signatures were abolished and all accidentals inserted every time they occurred, the exceptions to the general regularity would tend to get overlooked in the mass of accidentals. This applies particularly to music written in such keys as B major.

(5) If equal temperament were to be adopted for all music, it would no doubt be possible to eliminate the signs for sharps and flats by writing on a staff of seven lines and six spaces to the octave, and taking the interval between a line and an adjacent space to represent a tempered semitone. Experience has shown, however, that such large staffs are not easy to read, even for an experienced performer. The original Great Stave of eleven lines had to be divided into two by the omission of the middle line for this very reason.

(6) The present system is admittedly awkward for the notation of certain modern music not based on the diatonic scales. However, such music is not likely to be studied by a beginner, and, indeed, still forms only a small part of the repertory.

The initial difficulties of the musical notation are no greater than those which face the student of a new language or a new branch of mathematics. No real progress will be made by trying to evade them.

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Shalford,
Guildford.
May 30.

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[1] Nature, 149, 554 (1942).

Science and Science Teaching

Having listened to the discussions opened by Prof. Lancelot Hogben and by Mr. L. J. F. Brimble, reported in a recent issue of Nature[1], on the role of human applications in science teaching, it seems to me that something may be gained by examining, from a scientific point of view, the nature of science itself. Science, we are told, is a method of observation and classification of phenomena. But this is, metaphorically speaking, only its physiology. It has also an evolution and an ecology. How did it come into existence? In what surroundings does it flourish?

It is a sociological phenomenon, a function of human society, for every letter of it is the product of human minds working together, and of the fingers of more than one pair of hands. Moreover, it requires a certain state of social development before it can appear. During the greater part of the human era it has not existed; in some parts of the world it does not there to-day. The value of scientific method may seem as clear as noonday to us, but (taking samples of social life at random in space and time) this outlook has not been even the usual one.

Only in certain conditions has it been found 'paying' to use science, and therefore become customary to encourage it morally and financially. Only then has the germ of scientific method, always present in the human mind, made progress relative to other forms of mental activity. But in these circumstances science has 'paid' just because its findings proved true when put into *practice*. Its cultivation therefore depended on its verification, not 'in the test-tube' but 'in the works'. (This has extended recently to biology.) Here we have a two-way correlation between pure science and applied; neither can in fact exist without the other, like Newton's '"action" and "reaction"'.

Until recently it has been customary, both in authoritative appraisement and in teaching, to exalt pure science and neglect the interrelationship. Now, questioning these preconceptions, we must teach science as a form of human activity, as mankind's struggle to master Nature (including his own), wherein 'pure' and 'applied' are seen as parts of one whole, the strategy and tactics of man's war against ignorance and impotence. All science is applied knowledge, but some parts (the 'pure') have a wider field of applicability than others. What is not (ultimately) applicable is not science.

The test of the truth of an expressed scientific principle does not lie only in some original investigation in the past; it is still being tested in the present in its practical applications. Therefore there is no particular scientific merit in always teaching the original experimental method by which the principle was derived, or in a 'laboratory' method of experimental proof. How then, it will be asked, are we to awaken and keep alive in our students the investigatory spirit? Partly by description and reproduction of a few selected historic investigations as striking examples of scientific method. But these must be part only of a general treatment showing science in all its parts as a live, present-day inquisitive and progressive movement of mankind, illustrating its principles not only by historic derivations, but also largely by simple (for children) modern applications. Occasional serious discussion of projected or suggested applications will help to emphasize the importance of research. It seems worthy of consideration, too, whether we cannot cut out traditional treatment of some older principles, replacing them by wider generalizations in which they are included. Experimental technique should be taught only when it can be made to answer a question of genuine interest to the student.

In recent discussions on science teaching much has been said of the conflicting interests of future specialist and future 'general citizen', of future academic scientist and future technician, of 'humanist' and 'scientist'. But if the methods sketched above can be brought more into use, the whole of science teaching will be made more 'live', by being brought more into contact with the fronts on which mankind is advancing, to the benefit of all the categories of students mentioned, and so of mankind in general.

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[1] Nature, 149, 435, 447, 555 (1942).

CHROMATIC BEHAVIOUR*

CHROMATIC behaviour of Vertebrata, Crustacea and Hirudinea depends on specialized pigmentary effector organs, which are diffusely branching cells in which pigment migrates to the centre or periphery, thereby offering more or less obstruction to incident radiation. Such cells are present in the integument (or scales) of nearly all cold-blooded vertebrates and of most Malacostraca. Light is the most universal stimulus to their reactions.

Photic responses of vertebrates and of Crustacea involve three components. Any one of them may predominate. Any one of them may be negligible. All of them may co-exist in one and the same species, contributing more or less to the ordinary rhythm of colour change. The three components are as follows:

(*a*) A *primary dermal* reaction, which is independent of the eyes. This is probably the most archaic, since it is the only type of photic response among Hirudinea which possess melanophores. It is also the more *characteristic* light reaction of such reptiles as Chameleo or Phrynosoma, possibly also of some elasmobranchs.

(*b*) A *secondary ocular* reaction (black background response) normally evoked by transferring an animal from darkness to superior illumination in light-absorbing surroundings. Light initiates this reaction when it falls on a *B*-area located in the ventral part of the retina of the vertebrate eye, the more dorsal ommatidia of the isopod and the dorso-central ommatidia of the crustacean eye.

(*c*) A *tertiary ocular* reaction (white background response) normally evoked by transferring animals from superior illumination in light-absorbing to superior illumination in light-scattering surroundings. Light initiates the reaction when it falls on a *W*-area dorsal to the *B*-area of the retina of the vertebrate eye, on the latero-ventral ommatidia of the isopod eye and on the ommatidia of the ventral periphery of the decapod eye.

The *primary* dermal response is partly autogenous, that is, it is evoked by direct action of light on the melanophores, and partly due to dermal photoreceptors which bring into play the same co-ordinating mechanism as (*b*) above. In all vertebrates, except possibly some teleosts, the *secondary* ocular response depends on *reflex* liberation of the *B*-substance of the pars intermedia of the pituitary gland. The *tertiary* ocular response is the latest component in the evolutionary series; and its control is different in different groups of vertebrates. To a greater or less extent in reptiles and in Teleostei, direct nervous control has *independently* established itself as a controlling process; but in Teleostei it seems to be superimposed on a more archaic type of indirect control through reflex liberation of some hormone. Study of colour changes of Amphibia, of the eel and of elasmobranchs points to the conclusion that some part of the pituitary gland is either the seat of the latter or controls the functional activity of another ductless gland which produces it, possibly the supra-renal.

Electrical and tactile stimulation of certain receptive areas of reptiles which have an acquired direct nervous control of the pigmentary effector system can evoke a reaction like the tertiary ocular response; but electrical and tactile stimulation rarely evokes generalized chromatic response of other vertebrates. We have insufficient information to justify general conclusions about the way in which temperature or moisture evokes response of land vertebrates or terrestrial Crustacea.

The fact that so many species of vertebrates which possess pigmentary effector organs display no striking colour change in response to normal changes of the environment is partly due: (*a*) to specific variation of the resting level of hormone concentrations in the blood; (*b*) to a delicate adjustment of ocular orientation and external illumination necessary for the production of separate secondary and tertiary light reactions; (*c*) to more or less insensitivity of the chromatophores to incident illumination.

Control of chromatic behaviour of Crustacea is due to reflex liberation of at least two hormones, of which one is produced by a gland in the neighbourhood of the eye itself. The sinus gland of the eye stalk of Decapoda produces a hormone the reflex liberation of which evokes the black background response of Brachyura and the white background response of decapods other than Brachyura.

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[*] Substance of the Croonian Lecture of the Royal Society, delivered by Prof. L. Hogben, F.R.S., on June 18.

MANUFACTURE OF OPTICAL GLASS IN CANADA

THE story of Research Enterprises Ltd., the body which has undertaken the production of optical glass and instruments in Canada, has been told by its president, Colonel W. E. Phillips, in a paper presented to the Engineering Institute of Canada in February last. It is a fascinating story of difficulties overcome by determination and ability.

It was in October 1939 that General MacNaughton suggested to the War Supply Department that consideration should be given to the production of optical parts in Canada, but at that time for various reasons the matter did not make any progress. Later, it was re-opened by the Department of Munitions and Supply in connexion with an urgent demand for binoculars. Further investigation showed that the requirements ranged from binoculars to dial sights, including such highly specialized instruments as range-finders. To meet this demand, Research Enterprises Ltd. was organized in August 1940 as a wholly Government-owned company, operating under the Ministry of Munitions with the full freedom of a private enterprise. The need for optical glass was the immediate justification for the creation of the company, but it was intended that this should be followed by the production of a variety of optical instruments. Conditions in Canada were, of course, quite different from those in Great Britain, where a long-established separate industry supplies optical glass blanks to a number of experienced instrument firms, each of which is principally concerned with the production of a few specific types of optical instruments. In Canada provision had to be made for a completely integrated operation, starting with the raw materials for glass-making and ending with the delivery of twenty-five types of finished instruments.

On September 3, 1940, a start was made in Toronto with two employees. In January 1942 some three thousand optical instruments valued at about £120,000 had been made. The total number of employees was about 3,000, of whom 700 were women, and 100 staff of whom 84 were graduates of Canadian universities. This staff includes 56 graduate engineers, 20 physicists, 3 graduates in engineering physics, and 5 chemists. Research Enterprises Ltd., is, however, much more than a factory for the production of optical instruments alone. In November 1940 a demand was made for the production of various secret devices, and in point of fact the greater part of Research Enterprises Ltd. is concerned with these rather than with optical instruments.

It was immediately realized that if Research Enterprises Ltd. was to produce optical glass in a reasonable time, the best use would have to be made of existing knowledge and experience, and after a thorough study of the records of the difficulties met by the Americans in 1918, it was decided to follow the successful methods of Chance Brothers and Co. Ltd., of Great Britain. Arrangements were made with them in November 1940 to make available to Research Enterprises Ltd. every detail in connexion with the manufacture of optical glass, and personnel sent over from Canada were trained in the British factory; also, certain staff for the Canadian factory were recruited in Great Britain. It speaks well for the co-operation that existed to learn that the first melt was made on June 5, 1941, some seven months after the discussions were inaugurated between the two companies. The production of optical glass in the factory was some 12,500 lb. per month by January 1942, and with additional furnaces coming into operation it is estimated that the monthly yield should be 20,000 lb. of usable glass.

Of the actual production of optical instruments Colonel Phillips said little, but he indicated that the very serious difficulties that were met in the early days of the production had virtually been overcome by the beginning of this year. In the second week of January this year, for example, more than eight thousand individually finished polished optical components were turned out, and the rejection was less than 14 per cent.

The whole story is encouraging, and demonstrates how much can be accomplished if the urgency is sufficiently great and the desire to co-operate sufficiently emphasized.

PLEISTOCENE CLIMATES IN KENYA AND ABYSSINIA

By P. E. KENT

During the last few months the account by Erik Nilsson of his 1932–33 expedition to East Africa has become available in Great Britain[1]. In the course of this, Nilsson describes the continuation of his geological work in central Kenya, and a journey northwards to Abyssinia to extend the scope of the work and obtain comparative data in the more northerly section of the Rift Valley. The results obtained were of considerable interest. High-level beaches which were found in inland drainage basins proved to correspond closely with those known in detail in Kenya, and tuffaceous lacustrine deposits closely similar to those of the Lower-Middle Pleistocene of Kenya were located. Nilsson was also able to find and map moraines and other signs of past glaciation in two regions on the mountain masses.

Nilsson describes first his work in the Nakuru-Naivasha section of the Kenya rift valley, which began in 1927 with a period of collaboration with L. S. B. Leakey, and he claims to have been originally responsible for the recognition of the alternating wet and dry periods during the Upper Pleistocene, which have been related to an archæological time-scale by Leakey and further worked on by Solomon. There have been differences of opinion as to whether or not the older beaches in this basin have been tilted, and it may be commented that on the face of it the levels of shore-lines shown in Nilsson's diagrams (loc. cit., Figs. 18 and 19) appear capable of correlation in ways other than that shown, and do not seem clearly to establish evidence of tilting.

One of the most interesting references in the section of the paper dealing with Kenya is to the discovery by Leakey in 1932 of Stone Age implements in tuffaceous beds on a fault step and at the summit of the scarp forming the eastern wall of the Kenya Rift. Nilsson's opinion that there is no reason to doubt that the containing beds were true "Kamasian" and earlier than the rift faulting—which must, accordingly, be largely later than Middle Pleistocene—was endorsed by Dr. T. T. Paterson and the reviewer when shown the localities by Leakey in 1935. Evidence of recent movement of the Rift Valley faults has been obtained also in Uganda[2] and northern Tanganyika[3].

Nilsson leaves open the question of whether the Lower-Middle Pleistocene "Kamasian" beds of Kenya were laid down in a single lake (as Leakey[4] held) or in a series of lakes aligned along the Rift Valley, although he inclines towards the former. There is much evidence, however, that the uplift which raised East Africa from a low-lying peneplain to an area of high plateaux had been taking place throughout the Tertiary period, and it seems out of the question that a continuous sheet of water can have extended from Lake Rudolf to the summit of the uplift as recently as the late Lower Pleistocene.

In Abyssinia Nilsson first investigated the history of the Shala-Zwai inland drainage basin, situated in the Rift Valley about 75 miles south of Addis Ababa. The basin now contains four salty lakes, but high-level beaches cut into older Pleistocene lacustrine beds show that during the Upper Pleistocene the water-level was up to 150 metres higher, and the separate lakes united in a single, much greater sheet of water over a relatively long period. An extension within very recent times is shown (as in Kenya) by numerous dead trees near the lake shore, 'drowned' by a period of higher water-level.

Lake Tana, the source of the Blue Nile, was found to have owed its origin to damming by lava flows during the last inter-pluvial period, and the sequence of high-level beaches can be correlated in detail with that of the Zwai-Shala and Nakuru-Naivasha basins, but sediments earlier than the Upper Pleistocene are absent. East and south of Debra Markos, however, the Blue Nile flows across an area of the older sediments, named by Nilsson Lake Yaya from the locality of best development. From lithological characters and degree of denudation the beds are provisionally dated as Lower Pleistocene, although faunal evidence of age has yet to be obtained.

Nilsson's comparison of the histories of the Abyssinian lakes with those of Kenya and with the Faiyum depression of Egypt shows a good degree of correspondence. It is, however, based on the number and degree of intensity of wet periods, and the more positive evidence provided by archæological or palæontological dating would be desirable for confirmation of the correlation.

In continuation of his work on the history of glaciation of the mountains of Kenya, Nilsson investigated the largest of the denuded volcanic mountains hich stud the high plateau of Abyssinia. He first sited Mounts Kaka and Chillalo, south-east of ddis Ababa, finding well-developed moraine ridges xtending in the latter case almost 800 metres below he 4,100-metre summit, and he then travelled northrds across the Hawash valley to the Highlands of nien, which lie on the northern edges of the yssinian plateau. On the highest three peaks of ne worn-down volcano forming these highlands he gain discovered extensive moraines and fresh-looking cirques, and shorter moraine ridges formed during the later stages of declining glaciation. Correlation of new data from Abyssinia with the results tained on Kilimanjaro in Tanganyika, Mounts nya and Elgon in Kenya, leads Nilsson to the nclusion that the maximum extension and stages f recession of the mountain glaciers were simultaneous throughout East Africa.

Nilsson's second expedition is hence notable for the great area covered and for the further demonstration that the climatic history of East Africa is not purely local. Thus parallel phenomena are found over a very wide area, and there is a considerable degree of agreement with the standard successions of the Nile Valley and Mediterranean.

[1] "Ancient Changes of Climate in British East Africa and Abyssinia", *Geografiska Annaler*, **22**, Haft 1–2, 1–79 (Stockholm, 1940).

[2] Wayland, E. J., *Compt. Rend. XV Int. Geol. Cong.*, **2**, 323–53 (South Africa, 1929).

[3] Kent, P. E., *Geol. Mag.*, **78**, 173–84 (1941).

[4] Leakey, L. S. B., *Geog. J.*, **84**, 296–310 (1934).

THERMAL BREAKDOWN IN SUPER-TENSION CABLES

AN article by E. A. Beavis (Eng. Supp. *Siemens Magazine*, Nos. 202 and 203, March and April, 942) considers the various factors contributing to le failures in the sphere of dielectric heating. ny type of high-voltage cable installation there finite limit to the heat which can be dissipated, ve which the condition of the cable insulation thermally unstable. The chief factor governability is the dielectric loss, which has a critical value dependent partly upon the l constants of the cable but chiefly upon the al thermal conditions. When this value is d, cable breakdown becomes inevitable in urse of time, provided such conditions continue unchanged. This maximum value of dielectric loss, which denotes the commencement of instability, remains constant for a given set of thermal values, and the higher the applied voltage the lower is the critical temperature at which this loss occurs, since it increases as the square of the voltage. For the same conditions, therefore, the higher the voltage the shorter the time required for thermal breakdown to occur. Failure will normally take place when the mperature of the insulation has reached the point which the existing potential gradient exceeds the dielectric strength, and in most cases will occur shortly after passing the critical value.

For very high voltages, failure in some cases precedes the actual approach of instability by reason of educed dielectric strength consequent upon the high able temperature attained, and conversely with omparatively low voltages the time to breakdown ay occasionally be much prolonged on account of a dielectric loss/temperature characteristic reducing te of temperature rise. Should the thermal conditions change in such a way that the temperature tends to fall again below the critical point before breakdown takes place, then thermal failure will in general be avoided. In the case of super-tension cables of special design where ionization is suppressed, no permanent deterioration may take place under the above conditions, but with the normal sc [illegible] type cables distortion of the lead sheath will o [illegible] due to excessive expansion of the cable oil, tending to produce ionization on cooling which will probably render the cable unfit for service in course of ti [illegible]

On account of the increase in dielectric loss, the higher the applied voltage the less the thermal factor of safety for the same maximum conductor temperature. As it is often necessary for economical reasons to run the highest voltage cables at their maximum permissible temperature, it becomes essential to study carefully the thermal conditions for such installations in order to ascertain the limiting current-carrying capacity of the cable. Although it is now possible to calculate the thermal characteristics for any cable reasonably accurately from published data, it is customary to carry out special testing operations on short lengths of about thirty yards of various types of super-tension cable in the high-voltage laboratory. Such tests, usually denoted as stability tests, consist in running a series of loading [illegible]es on the cable conductors with superimposed v [illegible] ge, so as to simulate so far as possible the conditions in practice. Extending these tests by gradually increasing current and voltage on periodic cycles until thermal breakdown ensues enables the limits of thermal stability to be ascertained for the given conditions. Such tests are usually carried out in air with the cable laid out on the test house floor, the ends being properly terminated in porcelain insulators. From the results it is possible to calculate the critical temperature for any particular t [illegible] l condition, thus providing an indication of [illegible] hermal factor of safety in the given circumst [illegible]

For the purpose of calculating the [illegible]rmal breakdown phenomena the author shows the development of some of the heating formulæ which have been published earlier. These are dealt with under the headings of cable heating due to load current, and dielectric loss heating. Test results are given for various sizes and types of single- and three-core cables from 33 kv. to 132 kv. The examples show that, with accurate thermal data, it [illegible] possible to calculate the time/temperature e [illegible] reasonably closely and to predict the minimu [illegible] robable time for thermal breakdown, since this pra [illegible] ically approximates to the attainment of the critical temperature. Although in theory the cable may be thermal [illegible] stable up to this point, the actual va [illegible] of the dielectric loss is of no real practical significance, as [illegible] would be impossible for the cable to withstand such high temperature for long. However, the importance of the dielectric loss temperature coefficient and of the thermal resistance—mainly the external part, since the cable itself remains more or less constant—is definitely established with regard to thermal stability under working conditions. Since the critical temperature depends primarily upon these two characteristics, the ratio of critical temperature to working temperature can be looked upon as the thermal safety factor. It is evident that with high-voltage cables the relation between dielectric loss and temperature needs to be studied carefully in order that full allowance can be made for all the thermal factors of the installation.

[illegible]ANSFORMER NOISE

A PAPER by J. Swaffield (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 17, May, 1942) reports the main results of an investigation carried out (1935–37) by the British Electrical and Allied Industries Research Association on model cores under controlled conditions to provide fundamental information on transformer noise. The factors affecting core noise are flux density, magnitude and uniformity of the core clamping pressure, steel quality, lamination thickness, type and thickness of interlaminar insulation, and method of interleaving the laminations. The ranges of design variables covered by the tests were flux density, 8,000–16,000 lines/cm.² or higher; clamping pressure, 0–350 lb./sq. in.; qualities of steel, *E.S.* stalloy and stalloy; thickness of laminations, 14 and 18 mils; insulation between laminations, insuline, paper and scale only; type of joint, concentrated, distributed and none.

At 50 c./s. excitation, the noise was found to consist of 100 c./s. harmonics of which the 200 c./s. and 300 c./s. components usually predominated; no 50 c./s. harmonics were present. Noise is associated with the following fundamental sources of vibration: interlaminar fluxes, resulting in vibration of individual laminations; magnetostriction, resulting primarily in core vibration as a whole; forces between turns due to winding currents, resulting primarily in conductor vibration. The effects of the various factors upon emitted noise were found to be those now cited.

Harmonic intensity levels are all functions of flux density, which greatly influences noise quality and quantity. Clamping affects only the joint noise, which can be determined only by experiment; if it forms an appreciable proportion of the total, joint noise becomes important, as it is penetrating. The effects of joint noise appear to be present mainly in the noise emission at 400 c./s. and higher frequencies. Joint [illegible] be reduced greatly by careful core assembly, including interleaving. Very large clamping pressures are unnecessary and it is more important that the clamping should be effective in the region of a joint than large at any particular point. Immersion in oil has a considerable effect in suppressing joint noise. Great reduction in the core vibration combined with reasonable economy is not to be anticipated unless the magnetostriction effect is reduced, and only by a suitable modification in its magnetostrictive property can a change in the type of steel be expected to effect an improvement in noise emission. Thickness of stampings affects only the joint noise and is unimportant. The insulation used between stampings does not appreciably affect the noise. Interleaving, in conjunction with suitable clamping, tends to effect substantial reduction in joint noise. Noise contributed by the coils consists mainly of fundamental tone and is not generally important compared with core noise.

The noise emitted by a transformer is thus due mostly to magnetostriction in the core laminations and to core joints. In large transformers the effect of magnetostriction predominates, but in smaller units the joints may effect substantial modification of the noise caused by magnetostriction. The main characteristics of magnetostrictive noise can be calculated by determining the form of the vibration it induces in the core and analysing this to obtain a measure of the sound intensity at the various harmonic frequencies. Experiments on model cores showed that results so obtained are representative of the noise actually produced. Improvement can be effected by reducing the flux density, but this is not economical. In order to secure a perfectly quiet transformer both joint noise and magnetostriction noise must be eliminated. As the latter predominates in all but the smallest transformers, little improvement can be expected by reducing the former.

Since the main investigation was carried out, a series of noise-analysis measurements has been made on a commercial transformer in an oil-filled tank and in air. Apart from joint noise the tests indicated that oil-immersion of the core has little effect on the characteristics of the noise. Both series of harmonic analyses showed remarkable similarities to those given in the report; such results as were obtained all tended to confirm the conclusions reached by the investigator.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT CHIEF ELECTRICAL ENGINEER to the Letchworth Electricity Undertaking—The Chief Electrical Engineer, Electricity Works, Letchworth (July 2).

ASSISTANT DAIRY BACTERIOLOGIST—The Bursar, Seale-Hayn Agricultural College, Newton Abbot, Devon (July 4).

EDUCATIONAL PSYCHOLOGIST (MAN OR WOMAN)—The City Educatio Officer, 12 St. Giles Street, Edinburgh 1 (July 4).

LECTURER IN ENGINEERING SUBJECTS—The Principal, Kingsto Technical College, Kingston, Surrey (July 4).

FIRST ENGINEERING ASSISTANT in the Waterworks Department of the County Borough of Brighton—The Waterworks Engineer, 12 Bon Street, Brighton (endorsed 'First Engineering Assistant') (July 6).

PRINCIPAL OF THE BATLEY TECHNICAL COLLEGE AND SCHOOL OF ART—The Director of Education and Secretary to the Managers Batley Technical College and School of Art, Batley, Yorkshire (July 6

TECHNICAL ASSISTANT in the Electricity Department of the County Borough of Londonderry—The Town Clerk, Guildhall, Londonderr (July 7).

LECTURER IN ZOOLOGY (MAN OR WOMAN)—The Registrar, Universit College, Leicester (July 13).

ASSISTANT DAIRY BACTERIOLOGIST—The Principal, Harper A Agricultural College, Newport, Shropshire.

WOMAN LECTURER IN GEOGRAPHY—The Principal, Edge Hil ing College, at Bingley, Yorkshire.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Institution of Gas Engineers. Communication No. 246: 79 Annual Report and Accounts of the Council of the Institution of G Engineers to be presented at the 79th Annual General Meeting to held in London on the 10th June 1942. Pp. 32. Communication N 248: The Gas Industry; Further Considerations on Efficiency a Development. Pp. 68. (London: Institution of Gas Engineers.) [

Empire Cotton Growing Corporation. Progress Reports fro Experiment Stations, Season 1940–1941; Programmes of Exper ments, Season 1941–1942. Pp. ii+216. (London: Empire Cotto Growing Corporation.) 3*s*. [8

Other Countries

Universidad de Buenos Aires. Facultad de Agronómia y Veterinaria. Jornadas Agronómicas y Veterinarias, 1937. Pp. 416. Jornadas Agronómicas y Veterinarias, 1939. Pp. 572. (Buenos Aires: Universidad de Buenos Aires.) [116

Proceedings of the United States National Museum. Vol. 92, No. 3134: The Freda, N. Dak., Meteorite, a Nickel-rich Ataxite. By E. P. Henderson and Stuart H. Perry. Pp. 21–24+4 plates. Vol. 92, No. 3138: A New Stomatopod Crustacean from the West Coast of Mexico. By Steve A. Glassell. Pp. 53–56. (Washington, D.C.: Government Printing Office.) [156

Imperial College of Tropical Agriculture. Report of the Governin Body and the Principal's Report to December 31st, 1941. Pp. 24 (Trinidad and London: Imperial College of Tropical Agriculture.) [15

Forest Research Institute, Dehra Dun. Indian Forest Leaflet N 12: Medicinal Products from *Pinus longifolia* Tar. By T. P. Gho and B. S. Varma.) Pp. ii+6. (Dehra Dun: Forest Research In tute.)